OBJECTIVES

Upon completion of this module, the trainee will be able to :

1. *Curing*
   - Define curing.
   - List and describe three methods of curing.
   - List and describe four methods of applying pickle cure.
   - List the common types of meat cuts subjected to the curing process, such as beef cuts and pork cuts.
   - Describe and explain five purposes for curing and smoking.
   - List three flavor enhancers used in cured meats.
   - List two cure accelerators used in curing.
   - Determine the percent gain procedure and identify allowable variations.

2. *Smoking*
   - Describe the term smoking.
   - Explain how the smoking process chemically reduces bacterial growth.

3. *Responsibilities*
   - List the two establishment responsibilities for producing cured and smoked meats.
   - List at least two responsibilities of an inspection program employee assigned to a cured and smoked meats operation.

4. *Restricted Ingredients*
   - List the most common restricted ingredients used in a pickle or curing formulation.
   - Describe the physical appearance of meat product to which nitrate and/or nitrite has been applied.
   - List the amounts of added substance allowed in different types of cured beef products, such as rounds, briskets, and tongues.

5. *Massaging*

   - Define product massaging.
   - List five advantages and three disadvantages of massaging.

6. *Calculations*

   - Calculate the maximum amount of all restricted ingredients allowed, when given a formula, and determine if the restricted ingredients used are in compliance.
   - Calculate the volume of a tank, when given the dimensions of a tank.
   - Calculate the maximum amount of cure mix allowed, based on percent of pump, when cure mixes are used in formulations that contain specific amounts of restricted ingredients.
   - Compute parts per million (ppm) of various ingredients in cured pork products at the time of pumping to determine compliance.

7. *Bacon Manufacturing*

   - Calculate the actual percent of pump allowed in pork bellies when given the weight of restricted ingredients and the volume and weight of the curing solution.
   - Calculate the yield of pumped pork bellies when given finished weight and green weight figures.
   - Calculate ppm allowed for each restricted ingredient approved for use in bacon products.
   - Identify restricted ingredients allowed in bacon products and the ppm allowed for each ingredient.
   - Define:

     a. Dry curing
     b. Dry salt curing
     c. Immersion curing

   - Identify where to find information necessary to:

     a. Select and submit samples for nitrosamine analysis;
     b. Determine inspection program employee actions based on sample results.

8. *Canned Perishable Products*

    - Identify the minimum labeling requirements for each.

9. *Protein Fat Free (PFF)*

    - Define PFF.
    - Calculate the weight reduction of a lot to comply with PFF regulations.
    - Place cured pork products within their respective groups.
    - Calculate PFF based on laboratory analytical results.
    - Determine which constants are to be used to calculate the Absolute Minimum PFF for Groups I-IV.
    - List the three sampling phases.

SCRIPT

INTRODUCTION

The art of preservation of meat products is as old as history itself. Preservation has been the result of necessity. In this country the Native Americans preserved their meat in the form of jerked venison and dried buffalo meat. Long before packing establishments developed, it had been found that cuts of meat could be preserved by treating them with a salt solution, or by packing them in dry salt. These salted meat items could be held for extended periods for later consumption. Since this meager beginning, the cured meat industry has evolved.

It is this expanding and fast changing industry that we in the food inspection program are charged with regulating; thus, our regulations and enforcement must, out of necessity, keep pace with industry development and technology.

The Protein Fat-Free (PFF) regulation reemphasizes the establishment's responsibility for monitoring compliance. The compliance system established by this regulation makes no pretense of "controlling", but is intended to detect whether or not the *plant* is controlling the process and preparing products in compliance.

The purpose of this module is to provide the inspection program employee with the necessary information essential to carry out this responsibility.

The inspection program employee must have a working knowledge of the industry in order to effectively determine process controls. This module correlates industry practices and techniques with FSIS regulations and will pinpoint areas of responsibility. There are some differences, such as frequency of sampling, etc. These differences, however, are based on the individual establishment's history of compliance or noncompliance.

This portion of the module begins by familiarizing you with the definitions of two terms that will be used throughout this module: curing and smoking.

- *Curing* is placing specific chemical agents in or on meat and poultry, such as pork ham, pork shoulder picnics, pork bellies, beef top and bottom rounds, beef knuckles, beef briskets, beef tongues, poultry cuts, etc.

- *Smoking* is subjecting meat and poultry cuts to an environment of smoke generated from hardwood, hardwood sawdust, corn cobs, or natural or artificial liquid smoke that has been transformed into a true gaseous state by applying direct heat.

As the process of meat curing developed, the meat packing industry emphasized four factors: preservation, flavor, color, and tenderness.

In past years, a fifth factor, yield, has come into the forefront. This factor has been stimulated by a highly competitive industry and consumer acceptance of a water-added product.

The following are descriptions of each factor as they apply to meat curing.

- *Preservation*

  To preserve meat and poultry, the undesirable microorganisms on the meat surfaces that cause spoilage must be inactivated and destroyed. One of the most effective means of accomplishing this is by introducing salt into the meat. The number of salt-resistant types of bacteria and other microorganisms varies widely. The growth of some bacteria is inhibited by

  salt concentrations as low as 2%, whereas other types are able to survive in salt concentrations up to the saturation point (26%).

Fortunately, the growth of many undesirable organisms normally found in meat and poultry products is inhibited at very low concentrations of salt. Since the salt has to penetrate the meat to preserve it, the temperature must be low enough to prevent decomposition and high enough to induce salt penetration.

- *Flavor*

Flavor is another factor of great concern to the packer. The flavor of cured meat is thought to be a composite result of the flavors of the curing agents and those developed by bacterial and enzymatic action. Because of the amount of salt used in the curing process, the salt flavor is the most predominant.

Sugar plays an important role as food for the flavor-producing bacteria of meat during long curing processes. Bacon may be the exception, in that after frying, it has a distinctly sweet taste. More importantly, because of the tremendous amount of salt used, sugar serves to reduce the harshness of the salt in cured meat and poultry.

The process of smoking gives product the characteristic smoke flavor. Smoking also acts to preserve flavor. To some degree, smoking is bacteriostatic (inhibits bacterial growth) and bacteriocidal (kills bacteria) to most surface organisms. Smoking also dehydrates the surface of the product, and deposits a resinous material on the meat surface due to the condensation of some phenolic and aldehyde compounds. These compounds produce an effective chemical barrier against growth and penetration of organisms. Excessive showering of product may remove some of the beneficial effects of the smoke and surface salt.

- *Color*

The next factor to consider is color. The development and maintenance of a stable red color is very important in cured and smoked meat operations. Sodium or potassium nitrate or nitrite are the cure agents used to process cured meats. Cure agents are responsible for the development of the characteristic stable red color in the meat. Nitrate is used as a source of nitrite. If nitrate is used as the cure agent, the conversion (reduction) of nitrate to nitrite by bacteria in the meat or poultry is a necessary step in the development of the cure color. The amount of nitrate that is reduced to nitrite is dependent upon the numbers of nitrate-reducing bacteria and several environmental conditions such as temperature, moisture content, salt content, and pH. Hence, the conversion rate and subsequent amount of nitrite that is formed is difficult to control. Similarly, the further reduction of nitrite to nitric oxide, which reacts with myoglobin (muscle pigment) to produce the cured color, is affected by the same environmental conditions. If nitrite is used as the cure agent, there is no need for the nitrate reduction step, and the development of the cure color is much more rapid.

If the cured meat is heated, exposed to a more acid environment, or left long enough under normal conditions, the nitric oxide myoglobin is converted into a stable red pigment called nitrosohemochrome. This is why a cured piece of meat remains red when heated and a fresh piece turns gray or brown.

The amount of color that develops during the curing process depends on

the amount of muscle pigment (myoglobin) present in the meat.

The time required for a cured color to develop may be shortened with the use of cure accelerators. Examples are ascorbic acid and erythorbic acid, or their derivatives, sodium ascorbate and sodium erythorbate. Cure accelerators tend to speed up the chemical conversion of nitrous acid to nitric oxide. Myoglobin must be in a reduced state to combine with nitric oxide. Cure accelerators tend to keep myoglobin in the reduced state and readily combines with nitric oxide.

Cure accelerators also serve as oxygen scavengers, preventing the fading of the cured meat color in the presence of sunlight and oxygen.

- *Tenderness*

Product tenderness is a processor's concern. Tenderness is more of a problem with certain beef cuts than with pork cuts. Consequently, more emphasis is placed on tenderness in beef. With the original methods of curing, which involved long periods of time, both pork and beef were excessively salty and tough. This toughness was probably due to the continued action of the salt dehydrating the meat fibers. With the advent of artery pumping, quick curing, and high temperature smoking, the packer could produce meats that were definitely more tender.

- *Yield*

This brings us to the fifth and final factor: yield. By necessity, the packer is very concerned with yields in cured and smoked meat and poultry products. The market is extremely competitive, thus adding to the incentive to produce noncomplying product.

Factors Affecting Yield

Phosphates. The use of phosphates in cured smoked pork products has been widely adopted by the meat industry. Its primary purpose is to reduce excessive shrinkage or "purge" (cook out) when the product is cooked.

Phosphates also increase the water holding capacity of the available protein in the product, without increasing the apparent saltiness of the product. Test results with phosphates indicate that their use to increase yields is much more effective at high processing temperatures, such as those used to produce fully cooked product.

Other Factors. Other factors that affect yield are smoking and cooking time, humidity, the type of casing used, i.e., pervious or impervious, and the addition of protein materials such as hydrolyzed plant protein, hydrolyzed vegetable protein, and monosodium glutamate.

Massaging. Massaging is used to increase yield. Massaging subjects meat chunks to mechanical treatment to facilitate protein extraction. This is accomplished by placing the product in a vat with an agitator or in a tumbler for varying periods of time depending upon the type of equipment used.

Basically the results of the treatment on the meat chunks are muscle fiber disruption with a corresponding release and coating of the muscle with a salt-soluble protein.

The protein then is heat-coagulated by cooking to form a binding matrix between muscle chunks, thus giving the muscle chunk an intact muscle appearance.

There are some distinct *advantages* in massaging. There is an accelerated brine dispersion in the cured product;

improved uniformity of cured color and texture; an enhanced release of salt-soluble protein (myosin) to produce a creamy, tacky, exudate; increased yield because of reduced weight loss during cooking; and facilitating binding without using prepared gelatins.

There are also some *disadvantages* with massaging. Excessive mechanical treatment may cause excessive muscle destruction. Insufficient treatment may cause product to exhibit poor binding and slicing characteristics. There is also the possibility of poor cure distribution, poor color development, and bacterial contamination due to excessive handling.

RESPONSIBILITIES

Establishment management has specific responsibilities for controlling product and processing procedures.

Establishment management has two primary responsibilities: control all restricted ingredients and procedures to ensure product compliance (e.g., curing, smoking, chilling) and adopt uniform procedures to minimize product variation. The inspection program employee is responsible for knowing plant production practices and control procedures; evaluating their effect on finished product; observing amounts of restricted ingredients used; calculating the percent of curing solution injected into product to ensure that restricted ingredients are properly used and pumping procedures are uniform; and sampling for laboratory analyses.

When solution is added to product, the preferred way to monitor it is to obtain the actual green (unpumped/untreated) weight and the actual pumped or treated weight. This is a more accurate way of establishing the percent pump or pickup. Another method to determine percent gain when it is not possible to obtain actual green and treated weights is by using different pieces of product for the green weight and for the pumped weight. All pieces chosen must be in the same weight range.

CURING METHODS

There are three general methods of curing, with a number of modifications for each method. These method are pickle curing, dry curing, and dry salt curing.

- *Pickle Curing or Curing Solution*

  A pickle cure could include water and salt (plain or salt pickle); a pickle that contains water, salt, nitrate, and/or nitrite; or a pickle containing water, salt, nitrate, and/or nitrite to which sugar has been added (sweet pickle). Other ingredients could be added to enhance flavor.

- *Dry Curing*

  Dry curing includes salt alone; salt, nitrate, and/or nitrite; or salt, nitrate, and/or nitrite with sugar. Product subjected to this curing method cannot be injected with, or immersed in, a cure solution.

- *Dry Salt Curing*

  A modification of the dry curing method is commonly referred to in the industry as dry salt curing, which includes the same mixtures in dry curing, except that product may be injected with cure solution directly into the muscle tissue (not through the circulatory system). Just prior to being covered with the dry mix, a product may be momentarily moistened to facilitate salt penetration.

- *Application of Curing Solutions*

There are several methods of applying curing solutions to meat cuts. It is important that the inspection program employee be familiar with the different methods of applying curing solution to meat and poultry cuts.

There are five basic methods to apply curing solutions to meat and poultry cuts.

Osmosis was the earliest method used. This method involves covering the meat cuts with dry cure or completely submerging the meat cuts in a curing solution for an extended period of time (2 to 6 weeks).

The *stitch method* injects curing solution deep into the muscle with a single orifice needle. This method is considered better than the submerging method because the packer can quickly get a deeper penetration of the cure.

Spray pumping is a variation of the stitch method using a needle with many orifices to allow for more uniform distribution of the pickle.

Artery pumping introduces the curing solution into the natural circulatory system.

The last method, *machine pumping,* is essentially the stitch method. The difference is that a machine with ten or more needles, sometimes spring-loaded for injecting bone-in product, is used. This method is considered more efficient and economical.

Whichever method is used, the inspection program employee should be familiar with pumping procedures and equipment.

PRODUCT CONDITION

From the standpoint of wholesomeness, the inspection program employee must be concerned with product condition because of the types of product involved (frozen or fresh).

Problems of off-condition or unwholesomeness are usually found in frozen products where handling, storage, and transportation are below standards.

If frozen product is received in an official establishment for further processing, e.g., curing and smoking, the establishment must observe the product for soundness and evidence of mishandling

Frozen product may be defrosted in water or a brine solution, except that defrosting product suspected to be unwholesome in brine is not allowed. The brine would tend to mask or camouflage off-condition meat or poultry.

Defrosting product suspected to be unsound is permissible, providing adequate facilities are available that do not create undesirable conditions in edible departments, e.g., a separate room and racks designated for this purpose.

Unclean surfaces of frozen product must be made acceptable before defrosting in water or brine.

Care should be taken by the establishment to assure that defrost water is not contaminated with loose materials from cartons.

The defrost area should have adequate space, proper drainage, be curbed, and have water supply lines equipped to assure there will be no back-siphonage.

CANNED PERISHABLE PRODUCTS

Even though canned hams, picnics, and some canned poultry products are shipped in hermetically sealed containers, they are seldom processed to a sufficient internal temperature to be considered shelf-stable.

The usual procedure calls for hams and picnics to be cured as previously described. Once the cure ingredients are added to the product it is placed into a container and sealed. The cooking occurs by placing the container into a vat of heated water for a specific period of time.

- Special Labeling Requirement

  Due to low processing temperatures, these products must be held at refrigeration temperatures to prevent spoilage. Therefore, these products must carry on their label the words "Perishable—Keep Refrigerated" or "Keep Refrigerated" or a similar statement.

  For all perishable canned products this statement shall be shown in upper case letters ¼" in height for containers weighing 3 lb or less. For containers over 3 lb, the statement shall be in upper case letters at least ½" in height.

SUPPLEMENT INFORMATION

TITLE:	Cured and Smoked Meats
RESOURCES:	FSIS Regulations FSIS Directive 7620.3, Processing Inspector's Calculations Handbook Cured and Smoked Meat Module
SUPPLEMENTS:	Each supplement heading highlights the information for that supplement.
PURPOSE:	These calculations and references will provide the inspection program employee with sufficient knowledge to accurately determine compliance, and initiate appropriate actions during his/her monitoring of various cured/smoked meats procedures.
NOTE:	For the purpose of all supplement problems, an answer to 2 decimal points is acceptable. **Do not round up when calculating restricted ingredients.**

SUPPLEMENT 1

This supplement includes information on additives and the limitations for their use in curing compounds and solutions that are to be applied in or on meat and meat food products and poultry and poultry food products. Also included are some practice problems to compute maximum allowable amounts of restricted ingredients. FSIS Directive 7620.3, Processing Inspectors' Calculations Handbook can be used to assist you.

I. Additives [§318.7(c)(4) and §381.147(d)(4)]

A. Parts per million (ppm) of restricted curing ingredients permitted in curing solutions

1. Nitrate—Source of nitrite

   Dry cure—3½ oz per 100 lb of meat

   Pickle—700 ppm

   Nitrate is converted (by bacterial action) to nitrite and is a color fixer. Nitrate can be used in pickle alone. It can be used in pickle with nitrite. Inspection program employees should be encouraged to recognize it visually. The establishment should control it.

   (*Note*: Nitrate is **NOT** permitted as an ingredient in bacon.)

2. Nitrite—Color fixer

   Dry cure—1 oz per 100 lb of meat

   Pickle—200 ppm in finished product

   (*Note*: Nitrite is limited to 120 ppm in bacon.)

   Nitrite serves a dual purpose. It is principally used for color development. It is also considered a protective agent against botulin (toxin) formation. Since nitrite is highly toxic, nitrite and nitrite mixtures should be controlled by the establishment.

   Nitric oxide gases react and dissipate. It is well to note that these yellow gases are toxic when concentrated.

3. Ascorbic acid or erythorbic acid—color-fixing accelerator, color preservative
   In pickle, 469 ppm

   (*Note*: **NOT** allowed in bacon curing.)

4. Glucono delta-lactone—pH adjuster or acidifier (also acts as a cure accelerator)
   In pickle, 5000 ppm

5. Sodium acid pyrophosphate—color fixing accelerator
   In pickle, 5000 ppm

6. Sodium ascorbate or sodium erythorbate

   In pickle, 547 ppm

   (*Note*: 550 ppm in bacon.)

   Additives that accelerate color fixation also prolong color retention and increase shelf life by their action as oxygen scavengers.

7. Phosphates

   a. Decrease the amount of cooked-out juices
   b. In pickle, 5000 ppm
   c. Only clear solutions may be injected into product
   d. Phosphates must be “food grade” only and this must be clearly stated as part of the printed material on the phosphate container (bag), or be accompanied by a supplier’s letter of guaranty.

8. Binders and extenders

   a. Prevent purging of brine solutions
   b. Each approved binder must be used individually, unless otherwise stated. In some cases, certain binders and extenders may be combined, but only in specified amounts. (For more details, see §318.7(c)(4) and §381.147(d)(4).)
   c. Amounts permitted
      (1) Carrageenan—**NOT** to exceed 1.5% of product formulation
      (2) Food starch modified— **NOT** to exceed 2% of product formulation
      (3) Sodium caseinate— **NOT** to exceed 2% of product formulation
      (4) Isolated soy protein— **NOT** to exceed 2% of product formulation

      The above binders are only approved for use in cured pork products labeled as "Ham with Natural Juices", “Ham, Water Added” and “Ham and Water Product—X% of Weight is Added Ingredients.”

9. Sweeteners

   a. Reduces harshness of salt, affects flavor somewhat
   b. Amount permitted
      (1) Sugar (sucrose) or dextrose—sufficient for purpose
      (2) Brown Sugar—sufficient for purpose
   c. Saccharin—for bacon 0.01% in the finished product
   d. Saccharin must be identified and the label must bear the warning statement as expressed in the Standards and Labeling Policy Book (“Use of this product may be hazardous to your health. This product contains saccharin which has been determined to cause cancer in laboratory animals.”).

10. Salt

    a. Provides some flavoring and preservation properties
    b. Amount permitted
       Salt—sufficient for purpose

11. High protein additives

    a. Gelatin acts as a binder or congealer for certain meat food products.
       Sufficient for purpose [M 18.19(b)(2)]

    b. Monosodium glutamate (MSG), hydrolyzed "plant" protein (H"P"P), and hydrolyzed "vegetable" protein (H"V"P)

       Flavor enhancers—sufficient for purpose

       Note: On meat and poultry product labels, proteinaceous materials must be listed specifically. The terms "plant" and "vegetable" are **NOT** acceptable. It must be specified, such as hydrolyzed soy protein.

12. Smoke

    a. Characteristic flavor, color
    b. Approved hardwoods, such as: hardwood, hardwood sawdust, corncobs, corncob meal, redwood, redwood sawdust, mesquite wood, or mesquite sawdust
       [M 18.30(a)]

       Note: If product is labeled “Hickory Smoked,” certification must be provided to the inspection program employee indicating such sawdust or wood used for smoking is 100% hickory. [Standards and Labeling Policy Book]

II. Controls

In-plant control of restricted ingredients:

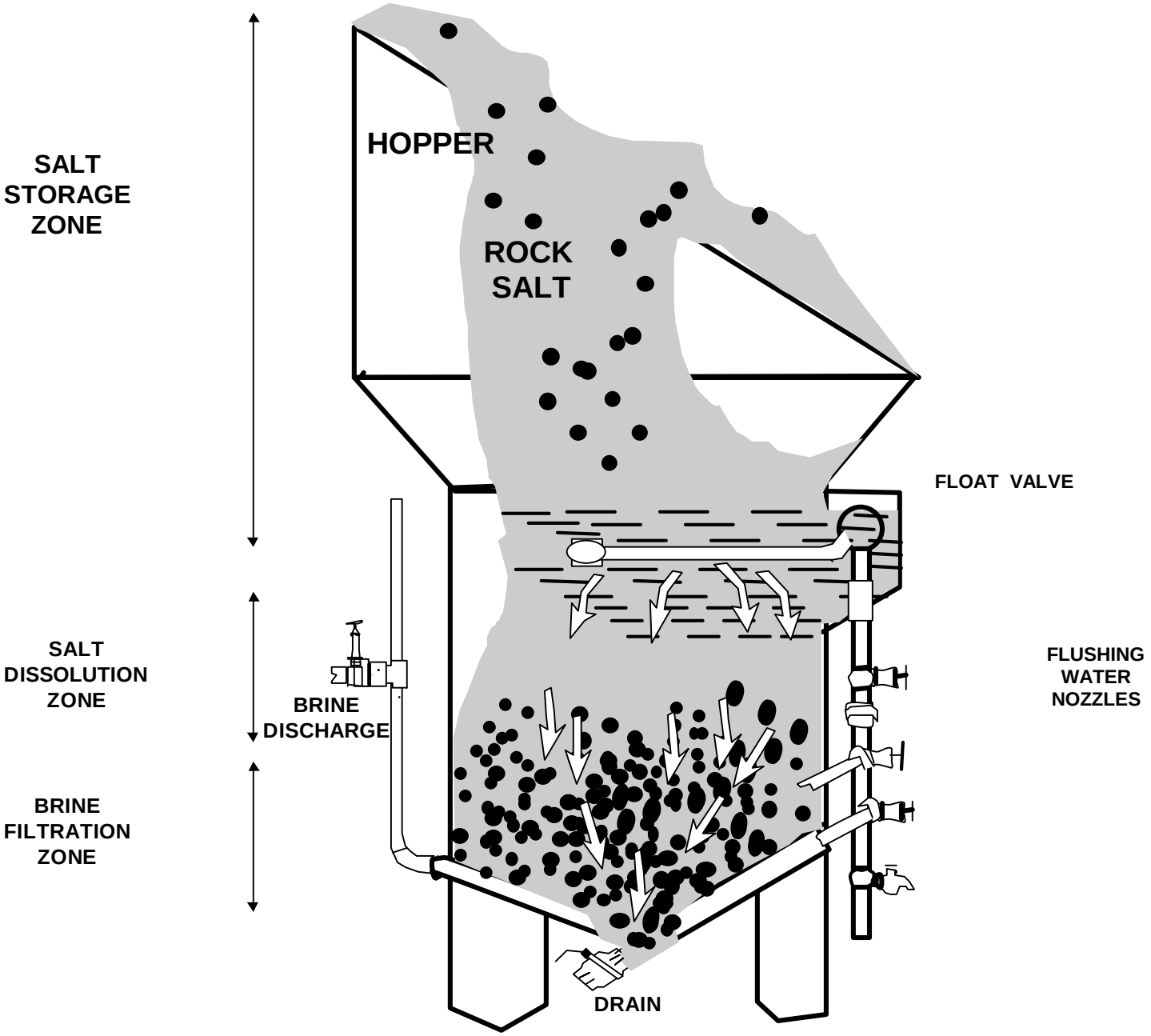
1. Establishment adherence to proven processing procedure chart
2. Accurate pre-batch measurement

III. Brine Formulation

A. Some operations prepare brine in 100° salometer strength (saturated solution approximately 26% salt by weight). This is then diluted to the desired strength at the time of formulation.

The most common method used to prepare 100% strength brine is to use a piece of equipment frequently referred to as a lixator. (See the following page for a diagram showing a typical lixator.)

LIXATOR


SALT STORAGE ZONE
HOPPER
ROCK SALT
FLOAT VALVE
SALT DISSOLUTION ZONE
BRINE DISCHARGE
FLUSHING WATER NOZZLES
BRINE FILTRATION ZONE
DRAIN

The operating principle is simple. The lixator uses rock salt for both dissolution and filtering. Water is introduced near the top of the lixator through a float valve and flows downward through the bed of rock salt. This valve holds the brine at a fixed level and automatically opens when brine is withdrawn, feeding water at a rate equivalent to the brine being withdrawn. When the water has dissolved enough salt to become a fully saturated brine, it can dissolve no more.

The lower the mass of the salt bed is therefore not dissolved. It remains as a natural filter through which the now fully saturated brine must pass into the brine-collecting chamber. Any small quantity of insoluble materials that might get into the salt during handling is released and removed from the solution by this self-filtration. Since the brine is not agitated, it does not pick up and hold insolubles in suspension. The filtered, saturated brine flows by gravity to the storage tank. A filtering device should be located somewhere between the brine discharge valve and the storage tank. Since most of the meat spoilage bacteria cannot survive high salt concentrations, this high concentration of salt brine is basically free from brine bacteria.

At 60° F, one gallon of saturated brine weighs approximately 10.03 lb and contains approximately 2.64 lb salt or 26.4% salt. Additional salt will settle to the bottom of the container.

B. Restricted ingredients are computed for 100 gal of pickle at 10% pump. [§318.7(c)(4)]

C. The temperature of pumping pickle usually runs from about 40°F to 70° F.

D. Pumping pickle may also be used as a cover pickle.

E. Product covered with cover pickle for any length of time should be checked by the inspection program employee to assure the amount of gain does not affect procedural controls.

F. Pickle, after mixing, should be continually agitated to assure a uniform blend of the curing agents in the pickle.

G. Phosphates tend to precipitate out of pickle if not agitated.

H. Pickle must be adequately filtered before reuse.

1. Filters should be effective and easily checked.
2. Disposable filters on intake lines are sometimes used.

I. Pickle is often reused, but it should be clear, free of sediment, and show no evidence of decomposition. [M 18.20(e)(6)]

Mechanical pumping devices are sometimes used for this purpose when pickle spills directly from the product and the needles. However, the pickle should pass through an effective and continuous filtration procedure.

J. Pickle formulation sample problem

First, when the pickle is measured by volume, not weight, determine its weight by multiplying the number of gallons of water by 8.33 (the weight in pounds of a gallon of water) and adding the actual weight of the other ingredients. Next, if two parts of your equation are known, the third can be calculated by substituting the known values using the following equation:

$$\text{ppm (parts per million)} = \frac{\text{lb RI (Restricted Ingredients)} \bullet \text{\% Pump} \bullet 1{,}000{,}000}{\text{lb Pickle}}$$

1. Solving for parts per million (ppm) in product

An example procedure calls for 10% pump, 100 gal of pickle weighing 1,000 lb, and 2 lb of sodium nitrite.

("X") = unknown

$$X = \frac{2 \bullet 0.1 \bullet 1{,}000{,}000}{1{,}000}$$

$$X = \frac{200{,}000}{1{,}000}$$

X = 200 ppm

2. Solving for maximum pump permitted

Pickle "A" contains 1 lb 12 oz. of nitrite for 1,000 lb. What percent of pump is permitted?

Calculation: Convert 1 lb 12 oz. to 1.75 lb nitrite allowed at 200 ppm

$$200 = \frac{1.75 \bullet X \bullet 1{,}000{,}000}{1{,}000}$$

In *this* instance, you'll want to move all your known values to the left side of the equation, leaving "X" on the right and keeping it in the numerator. To transfer a value from one side of the equation to the other, simply move it to the numerator on the other.

$$\frac{200 \bullet 1{,}000}{1.75 \bullet 1{,}000{,}000} = X$$

$$\frac{200{,}000}{1{,}750{,}000} = X$$

0.1142 = X

11.42% pump allowed

3. Solving for maximum amount of restricted ingredient

Establishment 38 is using a cure mix with 6.25% nitrite. The establishment is planning to pump hams at 12% using cure mix. How much cure mix can the establishment use per 100 gal of pickle at this level of pump if the pickle weight is 9.5 lb per gallon?

Calculation: $$\frac{200 = X \bullet 0.12 \bullet 1{,}000{,}000}{950}$$

In this instance, you'll want to move all your known values to the left of the equation, leaving "X" on the right where it is in the numerator.

$$\frac{200 \bullet 950}{0.12 \bullet 1{,}000{,}000} = X$$

$$\frac{190{,}000}{120{,}000} = 1.58 \text{ lb nitrite allowed per 100 gal of curing solution}$$

Special Note: To find the amount of cure mix allowed, you divide the amount of nitrite allowed (in this case 1.58 lb) by the percent nitrite in the mixture (in this case 6.25% nitrite).

$$\frac{1.58}{0.0625} = 25.28 \text{ lb cure mix allowed in each 100 gallons of pickle}$$

4. **Determining volume in a tank**

Pickle tank "C" is a rectangular tank with these specifications:

Length = 60 inches; Width = 48 inches; Height = 48 inches

How many gallons will it hold when completely filled?

Special Note: There are 231 cubic inches in a gallon and 7.48 gallons in a cubic foot.

ANSWER: $$V = \frac{LWH}{231}$$

$$V = \frac{60 \bullet 48 \bullet 48}{231}$$

$$V = 598.44 \text{ gal}$$

Special Note: When calculating for restricted ingredients, remember that the tanks are never filled to the brim. Therefore, it is wise to calculate for gallons per inch of depth and multiply the gallons per inch by the height in inches that the tank will be filled.

5. Determining volume in a partially filled tank

Pickle tank “D” has these specifications

Length = 65 inches; Width = 60 inches; Height = 48 inches

How many inches from the top would 600 gal measure in this tank?

ANSWER: $V = 65” \bullet 60” \bullet 48”$

$$V = \frac{187200}{231}$$

$V = 810.39$ gallons

$$V = \frac{810.39}{48}$$

$V = 16.88$ gal per inch

$V = 600 \div 16.88$

$V = 35.55$ inches in tank

$V = 48 – 35.55$

$V = 12.54$ inches or 12.5 inches from the top of the tank

SUPPLEMENT 2

This supplement includes examples and/or practice problems designed to assist the inspection program employee in determining:

- Percent gain (pump/pick-up) tests;
- Percent cooking shrink tests;
- Percent cooler shrink tests;
- Interpretation of processing procedure charts; and
- Maximum amounts of restricted ingredients allowed.

It also provides information on:

- Curing of beef products; and
- Laboratory sampling.

Inspection System Procedure Codes

The proper procedure codes used for cured and/or smoked items may not always be readily apparent. Below are three commonly used codes for the products covered in this module.

04A01
This code refers to products with specific regulatory requirements, or label declarations (e.g., "Flavored with…") for yield, shrink and/or green weight restrictions. Examples of this are bacon and corned beef briskets.

04A02
This code is used only to determine the X% added solution (declared added substances). If the label does not declare an X% of added solution, then this code is NOT used. An example of this is "Boneless Ham, 18% Added Ingredients Consisting of Water, Salt, Dextrose, Sodium Phosphate, Sodium Nitrite."

04B04
Even though this code is often considered only for looking at labels, it also includes ***proper*** labeling. 04B04 is used to document compliance/ noncompliance with restricted ingredient requirements when these are not food safety related (e.g., binders, extenders, flavorings, coloring agents). In these cases, noncompliance occurs only when the order of predominance on the label is affected or the ingredient exceeds permissible amounts. Restricted ingredients must be monitored to ensure proper labeling of product. One way to monitor restricted ingredients is to perform a percent gain test. Examples here include any meat or poultry item that is pumped. Too much added solution can affect the product by causing it to be adulterated. In this case, this code is used because the product would be misbranded.

Part I

I. The Percent GainTest

A. Establishment's Responsibilities

1. Have procedures in place to ensure regulatory requirements are met. For example, the plant may lot product to be pumped (e.g., hams, picnics), into two- to three-pound weight ranges.

2. Furnish all necessary assistance (labor) to the inspection program employee in order that the test be conducted rapidly and accurately.

3. Assist in determining the tare weight of trucks or containers.

4. Provide accurate scales, lighting, tanks, and carts necessary to conduct the test.

B. Inspection Program Employee's Responsibilities

1. Perform gain (pump or pick-up) tests as necessary to ensure compliance.
2. Conduct gain tests per the Procedure Schedule and at unannounced intervals to insure plant conformity with procedure.
3. Follow the test procedure as outlined below.
   a. Select enough fresh (unpumped) product to represent the lot.
   b. Select the same product after pump.
   c. Compute the gain.
   d. Determine compliance as compared to the establishment processing procedure.

C. Exercises

1. A pump test shows 30 fresh, uncured hams had a green weight of 450 pounds; the same 30 pumped hams had a weight of 510 pounds.

   What percent gain does this test show?

   Answer: 510 – 450 = 60 lb

   60 ÷ 450 = 0.133 or 13.3% gain

2. A second test was conducted on 25 pork shoulder picnics. The procedure indicates a 19% pump.

   Pumped weight = 241½ lb; Green weight = 210 lb

   What is the gain?

   Answer: 241.5 – 210 = 31.5 lb gain

   31.5 ÷ 210 = 0.15 or 15% gain

If a consistent pattern of underpumping is identified, then the inspection program employee may suggest that management adjust the procedure to reflect the actual pumping percentage. Pumping equipment is checked for accuracy daily by the establishment and spot checked by the inspection program employee. Product should be identified prior to pumping, at the time of pumping, and through all phases of processing.

II. Cured Beef Products: §319.100 – §319.103

A. Corned beef

Corned beef shall be prepared from beef brisket, navels, clods, middle ribs, rounds, rumps, or similar cuts using one or a combination of the curing ingredients specified in §318.7(c)(1) and (4).

B. Corned beef brisket

In preparing *corned beef brisket, the* application of curing solution to the beef brisket shall not result in an increase in the weight of the finished cured product of more than 20% over the weight of the fresh uncured brisket. Any corned beef brisket whose weight after pumping exceeds 20% over the weight of the fresh uncured brisket may be prepared if the products are descriptively labeled to indicate the presence and amount of the additional substances. Examples of product names include: "Corned Beef Brisket and _____% Water"; or "Corned Beef Brisket and Water Product--___ % of Weight is Added Ingredients." (The ingredients of the added solution may be incorporated into the product name, e.g., "Corned Beef Brisket and Water Product--___ % of Weight is Added Water, Salt, Sodium Phosphate, and Sodium Nitrite.") The actual percentage is determined by subtracting the green weight of the beef from the pumped or treated weight of the product, and dividing by the green weight of the beef. This calculation is for ***uncooked*** product.

C. Corned beef round and other corned beef cuts

In preparing *corned beef round* and other corned beef cuts (except "corned beef brisket"), the curing solution shall be applied to pieces of beef weighing no less than one pound. Such
application shall ***not*** result in an increased weight of more than 10% over the weight of the fresh uncured beef cut. Corned beef cuts (other than beef briskets) whose weight after pumping exceeds 10% over the weight of the fresh uncured beef cuts may be prepared if the products are descriptively labeled to indicate the presence and amount of the additional substances. Examples of product names include: "Corned Beef and % Water" or "Corned Beef and Water Product--____ % of Weight is Added Water, Salt, Sodium Phosphate, and Sodium Nitrite"). The actual percentage is determined by subtracting the green weight of the beef cuts from the pumped or treated weight of the product, and dividing by the green weight of the beef cuts. This calculation is for ***uncooked*** product.

D. Cooked corned (cured) beef products

In preparing cooked corned beef, the application of curing solution to beef products shall not result in an increase of weight over the weight of the fresh uncured product.

Cooked corned beef products, whose weights after cooking exceed the weights of the fresh uncured beef, may be prepared if the products are descriptively labeled to indicate the presence and the amount of the additional substances. Product names that are acceptable include "Cooked Corned Beef and ___ % Water" or "Cooked Corned Beef and Water Product -- . % of Weight is Added Ingredients." The ingredients of the added solution may be incorporated into the product name, e.g., "Cooked Corned Beef and Water Product--_____% of Weight is Added Water, Salt, Sodium Phosphate, and Sodium Nitrite." The actual percentage is determined by subtracting the weight of the fresh beef from the weight of the finished product and dividing by the weight of the finished product. This calculation is for ***cooked*** product.

E. Cured beef tongue

In preparing *cured beef tongue,* the application of curing solution to the fresh beef tongue shall ***not*** result in an increase in the weight of the cured beef tongue of more than 10% over the weight of the fresh uncured beef tongue.

F. Controls

1. Beef Tongues: Tongues are usually artery-pumped and placed in a cover pickle for 4 to 7 days. Due to their size and the fact that they retain pickle very well, it is quite easy to pump tongues to a high percentage of gain. The percent pump can be quite accurately determined by a lot method provided they are cured in lots of uniform weight ranges. Since FSIS does not require a minimum temperature on smoked tongues, it is even more important that a proven procedure is followed to produce product compliance.

   In this type of product, the percent of pump is very important since there will be little or no pickle loss after the product is pumped. It is important for the inspector to be thoroughly familiar with the operation and be sure that the procedure will result in compliant product.

2. Beef brisket: Briskets are cured in essentially the same way as tongues except that many of them are pumped by injection rather than artery-pumped. The determination of percent pump by the injection method could, of course, be conducted in the same manner as with
   hams, that is, determine the weight of the same pieces before and after pumping. However, the brisket must be lotted in 2-to-3 pound weight ranges to determine the pump percentage if the exact same pieces are not weighed as green and pumped.

   It is necessary that effective controls be implemented to prevent adulteration with excess cure solution. One way to accomplish this is with in-plant "weight control." The establishment may submit lab samples periodically to determine the effectiveness of the control.

   The establishment could positively identify the product by placing a tag bearing the date, product name, curing ingredients, green weight, piece count, pumped weight, signature of establishment employee, and lot number on each container (vat, truck, drum, etc.) of briskets.

During the curing period, if pieces are removed from any container, the plant should enter the number and weight of pieces removed on the tag attached to the container. The establishment should check any or all containers at the time of shipment (up to ½ hour after cover pickle has been drained). The weight and number of pieces removed during the curing period is added back to the shipping weight to facilitate correct calculations for percent gain (no more than 20% over green weight).

Note: If briskets are trimmed, the weight of trimmed material must be added back when calculating shipping weight or the shipping weight can be calculated prior to trimming. Product containing more than 20% gain must be retained and shrunk to only 20% gain before it is released for shipment.

With the exception of the lower yield (10%) and the fact that most of them are machine or stitched-pumped, other cuts of corned beef are cured in the same manner as briskets. Controls should be essentially the same.

Many of the in-plant controls are dependent on weights, which must be obtained from establishment scales. Unless they are accurate, the figures are meaningless; therefore, scales should be checked regularly. The same holds true for the pumping scales in the case of artery pumping. Unless the scales are accurate and the operations use them properly, they offer a false sense of security. According to the item or the procedure requirements, the product may immediately be hung on trees or placed into cover pickle for specified periods.

3. Turkey ham (§381.71) is fabricated from boneless turkey thigh meat, with the skin (and surface fat attached to the skin) removed. It is cured and may or may not be smoked. The finished product weight shall not exceed the original (green) weight of the thigh meat prior to curing. A qualifying statement, "Cured Turkey Thigh Meat," is required. An additional descriptive statement ("Chunked and Formed," "Ground and Formed," or "Chopped and Formed" as appropriate to indicate particle size) is needed if the thigh meat was cut through the muscle during preparation.

   If the finished product has not returned to the green weight of the thigh meat, the label must include, in addition to the name "Turkey Ham," words that specify the amount of additional substances. For example, product may be labeled as "…and _ % Water,"
   "With __ % Water Added," or "Turkey Ham and Water Product--____ % of Weight is Added Ingredients," or the ingredients can be listed as "Turkey Ham and Water Product--
   __ % of Weight is Added Water, Salt, Dextrose, Sodium Phosphate, and Sodium Nitrate." The blank is filled in with the percent determined by the difference between the green weight of the turkey thigh meat and the finished product weight, then dividing by the finished product weight and multiplying by 100.

III. Smoking and/or Cooking

A. There must be a strict adherence to procedures, e.g., time, temperature, and humidity. Occasionally, smokehouse instrument charts are checked against a known accurate thermometer to determine the accuracy of the recording devices.

B. Yields—Weight Out, Weight In

The calculation to determine yield is

$$\frac{\text{wt out}}{\text{wt in}} \times 100$$

C. Temperature requirements

1. Pork products must meet trichinae requirements, e.g., 144°F (instant) or as identified in the heating chart in §318.10(c)(1).
2. Tender (see FSIS Directive 6810.2) pork products must meet trichinae requirements *and* have reached an internal temperature of at least 140°F.

   (*Note*: "Tender" refers to products labeled as tender smoked ham, tender smoked pork shoulder picnic, tendered smoked ham, tendered pork shoulder smoked picnic, etc.)

3. Cooked pork product must meet trichinae requirements.

   (*Note*: "Cooked" refers to products labeled as cooked smoked ham, cooked smoked pork shoulder picnic, cooked ham, cooked pork shoulder picnic, etc.)

   The product label usually carries cooking instructions.

4. "Fully cooked," "ready-to-eat," "thoroughly cooked," "ready-to-serve" and similar terms may be applied to heated and smoked products provided they exhibit characteristics like:

   a. Partial meat separation from the bone
   b. Easy tissue separation
   c. Cooked color, flavor, and texture

   This usually requires a minimum internal temperature of 148°F, except in the case of poultry. This temperature is a labeling requirement, not a food safety requirement. For food safety purposes, it may be necessary to exceed 148°F.

5. Bacon and jowls are not required to meet a minimum temperature since they are ordinarily cooked before eating.

6. Baked implies the product reached 170°F, has a brown crust on the surface, surface fat is rendered, and sugar, if applied, is carmalized.

7. For cured and smoked poultry products (rolls, etc.) labeled as "fully cooked," "ready-to-eat," "baked," or "roasted," the internal temperature must reach the temperature determined by the establishment to meet the lethality performance standard (§381.150).

Partially cooked poultry breakfast strips must be produced using processes ensuring that the products meet the performance standard for stabilization in §381.150. Labeling for these products must comply with §381.125. In addition, the statement "Partially Cooked: For Safety, Cook Until Well Done" must appear on the principal display panel in letters no smaller than ½ the size of the largest letter in the product name. Detailed cooking instructions shall be provided on the immediate container of the products.

D. Cooking (smokehouse) shrink sample calculations

1. The plant may record or periodically determine the cooking shrink. This is ***not*** a procedure required of inspection program personnel. The formula is explained here only to demonstrate how an establishment calculates the cooking loss.

$$\frac{\text{wt of product going into smokehouse} - \text{wt of product out of smokehouse}}{\text{wt of product going into smokehouse}} \times 100$$

2. Example

The weight of 60 hams on a smokehouse tree going into a smokehouse is 990 lb. This product had been pumped at 10%. This same tree coming out of the smokehouse was 910 lb. What is the percentage of smokehouse shrink?

$$\frac{990 - 910}{990} \times 100$$

80 ÷ 990 = 0.0808 or 8% shrink

E. Cooler shrink example calculation

1. Similar to the cooking shrink, the establishment may track cooler shrink. Here is the formula used for this purpose.

$$\frac{\text{wt of product going into cooler} - \text{wt of product after minimum chill time}}{\text{wt of product going into cooler}} \times 100$$

2. Example

The weight of 60 hams on a smokehouse tree (hot weight) going into the cooler is 910 lb. The weight of the same 60 hams after minimum chill time is 895 lb.

$$\frac{910 - 895}{910} \times 100$$

15 ÷ 910 = .0164 or 1.6% shrink

IV. Curing Problems

Curing Problem 1

A bone-in ham pickle was prepared in a 200-gallon batch weighing 2,000 pounds. The intended pump was 14%.

The tank used for mixing this pickle has these dimensions:

40” length; 40” width; 30” height

The 200-gallon mark is located 3” from the top of the tank.

The restricted ingredients used in the pickle formula were:

Phosphate—72 lb; Nitrate—8 lb; Nitrite—2 lb 10 oz.; and Ascorbate—5 lb

QUESTIONS

1. Is the mark on the tank correct? (If not, identify where the mark should be for 200 gallons.)

2. Calculate the maximum percent of pump permitted for each restricted ingredient (based on 200 gallons.)

2. Based on the amount of restricted ingredients used in the pickle formula, what is the maximum percent of pump permitted?

_____ %

Curing Problem 2 (If needed, use the following blank pages to show your work.)

The establishment's procedure states that the boneless ham pickle solution is prepared in an 860-gallon curing vat. The total ingredients (including water) weigh 8,586 lb. The pump target is 12%.

(*Note*: The cure ingredients are combined in a curing compound.)

The cure compound label states:

Sodium nitrite	23%
Sodium nitrate	30%
Sodium erythorbate	25%
Salt carrier	22% .
Total	100%

What is the maximum amount of compound permitted in this formula?

_____ lb

Processing Procedures for Cured, Cooked, and/or Smoked Pork

STYLE Fully Cooked

EST. # 38 **PRODUCT** Smoked Ham **Weight Ranges** 14/16

PICKLE FORMULA

100 Gal Pickle weighing 1000 lb	LB	% PUMP
SALT	92.5	
CORN SYRUP	36	55
WATER 100 GAL	833	
PHOSPHATE	30	16.6
NITRATE	4	17.5
NITRITE	1.25	16
ASCORBATE	3.25	16.8
TOTALS	1,000	16

USUAL PROCEDURES

% PUMP	16
LB. PRESSURE	60
SPEED	—
BEGIN S.H. TEMP.	140° F
TIME	2 hours
MIDDLE S.H. TEMP.	160° F
TIME	2 hours
FINISH S.H. TEMP.	180° F
TIME	8 hours
TOTAL S.H. TIME	12 hours
INT. FINISH F°	152° F
% S.H. SHRINK	12%
% COOLER SHRINK	2%
S.H. HUMIDITY	70
COOLER TIME	24 hours

EST. REP. Rue De Bagga

PROCEDURE REVIEW

DATE	PUMP TEST			SMOKEHOUSE PERIODS						SHRINK			
	GREEN WT	PUMPED WT	% GAIN	FIRST		SECOND		FINISH		SMOKEHOUSE		COOLER	
				TIME	F°	TIME	F°	TIME	F°	HOT WT	%	CHILL	%
2/15	455	530		1:55	140	2:20	162	8:00	182	472 lb	10.94	458 lb	2.96
2/23	420	490		2:00	140	2:00	160	8:00	180	432 lb	11.83	422 lb	2.31

(Answer questions on the following page.)

Processing Procedures Chart Workshop

1. Calculate the maximum percent of pump permitted for each restricted ingredient.

   a. Phosphate _____ %

   b. Nitrate _____ %

   c. Nitrite _____ %

   d. Ascorbate _____ %

2. Is the % of pump indicated on the procedure chart acceptable?

   _____ Yes _____ No

   If you answered "NO", identify *by ingredient*; the percents not acceptable.

   _____; _____; ____; _____.

3. Calculate the pump tests and compare your answers to the procedure chart.

   Test dated 2/15 _____ % gain Write the % gains on the procedure chart.

   Test dated 2/23 _____ % gain

Cured and Smoked Meats Workshop

1. If the establishment is pumping 14% and making 14 gallons of pickle weighing 139 pounds, how much nitrite and phosphate is allowed?

   Nitrite _____ lb

   Phosphate _____ lb

2. In 50 gallons of pickle, weighing 498.75 pounds, pumping 15%, how much Prague powder (6.25% nitrite) could be used?

   Prague powder _____ lb

Cured and Smoked Meats Workshop (Continued)

3. a. How many gallons are contained in a cylindrical drum filled to within two inches of the top with pickle if the drum dimensions are 24" (diameter) X 30" (height)?

   _____ gal

   b. How much nitrite, nitrate, and ascorbic acid could be used if the establishment wants to pump 15%? (A gallon of pickle weighs 9.68 pounds.)

   Nitrite _____ lb

   Nitrate _____ lb

   Ascorbic Acid _____ lb

4. What is the volume of a tank that has the dimensions of L = 94", W = 40", and H = 39"? Give the gallon capacity and find the gallons per inch.

   Volume = _____ gal

   _____ gal per inch

Cured and Smoked Meats Workshop (Continued)

5. Ninety pieces of corned beef briskets weigh 895 lb green. Two pumped pieces, total weight 19.9 lb, are removed by the establishment. At time of shipment, 29 lb of fat are trimmed from the cured uncooked brisket. The briskets are then weighed—total weight, 1055 lb. Are the briskets in compliance? Indicate your calculations.

   _____ % gain

   _____ in compliance

   _____not in compliance

6. A marker, 3 inches from the top of a pickle tank (cylindrical with a cone), indicates 300 gallons. Is the marker correct? If not, why? Indicate by calculations.

   Tank dimensions are:

   Cylinder: 40”—diameter and 50”—height

   Cone: 15”—deep

SUPPLEMENT 3

This supplement includes information on bacon manufacturing, nitrosamine sampling, inspector actions, yield controls, etc. Included are sample problems for reference purposes. The Bacon Sampling Program, FSIS Directives 7310.6 and 10,520.1, Rev. 1, Bacon Yield Determination Questions/ Answers are additional sources of information.

I. Nitrosamine Sampling and Controls

A. Pumped and/or Massaged Pork Bellies [§318.7(b)(1)]

Only pumped pork bellies (injected with a cure solution) and massaged pork bellies (curing solution is added by massaging/tumbling) are subject to the nitrosamine sampling program.

(*Note*: Guidelines for selecting samples for nitrosamine analysis, and required inspector action when sample results indicate excessive levels if nitrosamine, can be found in *Bacon Sampling Program—A Self-Instructional Guide.)*

B. In-Plant Controls

1. Plant management should use proven formulas when producing bacon.

2. Certain ingredients shall be used in the manufacture of pumped pork bellies. The required amounts ingoing are:

   a. Sodium nitrite—120 ppm (potassium nitrite—148 ppm)
   b. Sodium ascorbate or sodium erythorbate—550 ppm

2. The formula for determining compliance of the procedure is:

$$\text{ppm} = \frac{\text{RI} \bullet \%\ \text{pump} \bullet 1{,}000{,}000}{\text{lb pickle}}$$

Example: A procedure calls for the use of 1.2 lb sodium nitrite in 100 gal of pickle (weighing 1,000 pounds) and pumping 10%.

$$\text{ppm} = \frac{1.2 \bullet 0.1 \bullet 1{,}000{,}000}{1{,}000} = 120 \text{ ppm}$$

3. The formula for determining compliance at the time of pumping is:

$$\text{ppm} = \frac{\text{RI} \bullet \%\ \text{pump} \bullet 1{,}000{,}000}{\text{lb pickle}}$$

Sample problem

Establishment 38 has a vat of green bellies weighing 1,635 pounds. After pumping, the vat of bellies weighs 1,782 pounds. The establishment is using 1.2 lb of sodium nitrite in 100 gallons of pickle weighing 1,000 lb. The procedure calls for a 10% pump.

Step 1: Determine *% of pump*

1,782 – 1,635 = 147 ÷ 1,635 = 0.0899 X 100 = *8.99% pump or 9.0% pump*

Step 2: Determine *ppm* based on actual % of pump

$$\text{ppm} = \frac{1.2 \bullet 0.0899 \bullet 1{,}000{,}000}{1{,}000} = 107.88 \text{ ppm}$$ **or** $$\text{ppm} = \frac{1.2 \bullet 0.09 \bullet 1{,}000{,}000}{1{,}000} = 108 \text{ ppm}$$

This plant procedure is in compliance!

(*Note*: Even though the bacon regulation requires 120 ppm sodium nitrite going into the product, the Agency allows a plus or minus 20% ppm variation due to variables such as pumping procedures, draining, purge, etc.)

5. Calculation to determine the 20% plus/minus variation

20% = 0.2 therefore 0.2 X 120 ppm = 24 ppm

	120 ppm		120 ppm
	- 24 ppm		+ 24 ppm
Minimum =	96 ppm	Maximum =	144 ppm

Therefore the sample in-plant pump test is considered acceptable because it is within the 20%
(96 ppm to 144 ppm) variation of the required amount.

(*Note*: **The 20% variation is only for actual pump test**, and is not to be used when determining pickle formulas or % pump for a procedure.)

II. Immersion—Cured Bacon [§318.7(b)(5)]

A. Pork bellies may be placed in a brine solution containing salt, nitrite and flavoring, or in a container containing salt, nitrite, and flavoring.

B. Sodium nitrite shall not exceed 120 ppm ingoing (based on the actual or estimated skin-free weight of the bellies).

III. Bacon made with Dry Curing Materials [§318.7(b)(6)]

A. The product shall be cured by applying a pre-measured amount of cure mixture to the belly, completely covering all surfaces.

B. Sodium nitrite shall not exceed 200 ppm ingoing (based on the actual or estimated skin-free weight of the bellies).

Labeling Dry Cured Bacon

1. Bacon labeled “Dry Cured” may not be injected with, or immersed in, a curing solution.

2. Bacon labeled “Dry Salt Cured” may contain a curing solution injected directly into the tissues but not through the circulatory system. It is then covered with dry curing mixtures.

IV. Sampling

A. Sampling to determine nitrosamine levels

Through the directed sampling, the inspection program employee samples bacon for nitrosamine analysis. Currently, only the Eastern Laboratory runs this test.

Note: The entry of the unscheduled procedure will be reflected on the Procedure Schedule as performed.

B. Sampling for added substance

Normally FSIS does not sample for added substance; therefore, the determination of solution gain above green weight will be accomplished by the inspection program employee’s in-plant % yield tests.

V. Bacon Yield Determination (FSIS Directive 7310.6)

(*Note*: Bacon produced by pumping, immersion, massaging, and tumbling will be monitored for the % of yield.)

A. Each inspection program employee assigned to a bacon-producing plant will:

1. Determine the yield of one or more lots.

2. Maintain the Bacon Yield Difference Log. (See page 53.)

3. Retain product when the yield difference value is equal to or greater than 3.00. (A minimum of 5 consecutive lots must be produced in compliance before returning to normal yield determination frequency.)

B. Responsibilities

1. The establishment is responsible for controlling bacon manufacturing to assure that the
finished product is in compliance with FSIS Regulations 318.2, 318.7, and 319.107.

2. The inspection program employee is responsible for:

   a. Monitoring the production of bacon to determine if the bacon yield is in compliance.

   b. Maintaining the Bacon Yield Difference Log (FSIS Form 7310-3, see page 53).

C. Procedure to determine bacon yield

1. Determine the total weight of 50 uncured (green) pork bellies of the same weight range (e.g., 10-12 pounds). Normally bellies are skinned and trimmed prior to pumping.

2. Determine total weight of 50 cured pork bellies that have:

   a. Completed the chilling cycle as described in the establishment's processing procedures.

   b. Previously undergone skinning/trimming prior to pumping.

***Note*:** When determining yield and comparing green weight to pumped weight, it is *not* necessary to compare the same uncured pork bellies as long as a comparison is done on pork bellies produced under similar conditions and all 100 are in the same weight range. For example:

- If any trimming or removal of any portion of pork bellies occurs after pumping/massaging, the weight of these trimmings must be added when determining the finished weight.
- If the green weight must be calculated with the skin on, the finished weight figures must include the weight of the skin.
- The comparison should only be made on lots of the *same* weight range.

3. Calculating % yield

   Determine the yield by comparing the weight of the uncured pork bellies to the finished weight (cured bellies ready for slicing) using this formula:

$$\text{Percent yield} = \frac{\text{finished weight}}{\text{green weight}} \times 100$$

Rule:

When recording the percent yield, always round to the nearest whole percent, i.e., when a percent calculates to a decimal of 0.5 or greater, round to the next whole number; decimals less than 0.5 are dropped. For example, 100.65 % = 101% yield, and 100.45 % = 100% yield.

4. Determining yield difference

(*Note*: The yield difference is defined as the difference between the actual yield and the regulatory requirement of no more than 100% yield.)

a. Located on page 51 is a chart used to determine the "Value Added" figure for various % yields. This chart is reproduced from FSIS Directive 7310.6.

b. To calculate the yield difference, use the following formula.

Value added + Previous yield difference = New (current) yield difference

5. Completing and maintaining the Bacon Yield Difference Log (FSIS Form 7310-3)

a. First column (% YIELD)
Enter the % yield calculated from the first test result.

b. Second column (VALUE ADDED)
Enter the value added. [This figure can be determined from the "Bacon Yield Difference Chart" (page 16.51). It is the figure directly opposite the calculated % yield.]

c. Third column (YIELD DIFFERENCE)
For the very *first test*, the yield difference *is* the Value Added. After the first test, the yield difference will be the result of adding the current "Value Added" figure to the previous "Yield Difference" figure.

d. Fourth column (INSPECTOR'S INITIALS)
Self-explanatory.

e. Fifth column (DATE)
This is the date the yield calculation test is conducted.

Refer to the Example Bacon Yield Difference Log located on page 53 and use the following examples to review the completion of the log.

Let's say that in Est. 38, the inspection program employee conducted the following yield tests over several days.

Test 1:
Weight range 10-12 lb--yield is 95% = -1.50 (VALUE ADDED)
95% = calculated % yield from his/her test
-1.50 = Value from Bacon Yield Difference Chart (page 51)
Yield Difference = -1.50; therefore -1.50 will be recorded in the Yield Difference column of the Bacon Yield Difference Log.

Test 2:
Weight range 12-14 lb--yield is 100% = -0.25 (VALUE ADDED)
Yield Difference = -1.50 + (-0.25) = -1.75; therefore –1.75 will be recorded in the Yield Difference column of the Bacon Yield Difference Log.

Test 3:
Weight range 12-14 lb--yield is 105% = 1.00 (VALUE ADDED)
Yield Difference = -1.75 + 1.00 = -0.75; therefore -0.75 will be recorded in the Yield Difference column of the Bacon Yield Difference Log.

Test 4:
Weight range 14-16 lb--yield is 108% = 1.75 (VALUE ADDED).
Yield Difference = -0.75 + 1.75 = 1.00; therefore 1.00 will be recorded in the Yield Difference column of the Bacon Yield Difference Log.

Test 5:
Weight range 10-12 lb--yield is 99% = -0.50 (VALUE ADDED)
Yield Difference = 1.00 + (-0.50) = 0.50; therefore 0.50 will be recorded in the Yield Difference column of the Bacon Yield Difference Log.

NOTE: Since the inspection program employee is monitoring a *process*, yield calculation tests can be accumulated and recorded on the same LOG regardless of which lot of product was monitored. For example, the first test was conducted on a lot of pork bellies with a range of 10-12 pounds. The second test was conducted on a lot of pork bellies with a range of 12-14 pounds. Despite any variations in weight ranges from one test to another, *each* test will be recorded chronologically according to the date each test was conducted.

CAUTION:

Because of the potential for a plant "underpumping" product to get the VALUE ADDED figure low, and thereby lowering the running tally, *THE MAXIMUM NEGATIVE VALUE THE INSPECTION PROGRAM EMPLOYEE WILL EVER RECORD IS -2.00.*

6. Interpreting bacon yield differences

    a. When the yield difference value is *less than* 3.00, the bacon process is considered to be in compliance with the regulations. Product moves freely.

    b. When the yield difference value is *equal to or greater than* 3.00, *all* bacon represented by the sample will be retained. The sample represents *all* weight ranges in process, from in-plant lotting and trimming of uncured bellies up to slicing.

    c. Complete an NR for each incidence involving retention of product. State that the bacon yield difference was 3.00 or greater. Use ISP 04A01 and mark the Product, Economic trend indicator.

    d. Verification of the establishment's proposed further planned actions will include holding and testing the next five consecutive production lots assure the value added from each lot results in a yield difference of less than 3.00.

7. Repeated yield differences of 3.00 or greater

When establishments repeatedly have yield difference values of 3.00 or greater, the FSIS inspection program employee should initiate the procedure identified under subparagraph VII.B of FSIS Directive 7310.6.

8. Establishment 38 has recently expanded its production to include curing and slicing bacon. The formula is provided on FSIS Form 10,520.1 (reproduced below).

   (*Note*: The establishment skins and trims all bellies prior to pumping. Lots are assembled in 2 lb weight ranges.)

Cured and Smoked Meats
December, 1999

This information collection is voluntary. This information is needed in order to monitor nitrosamine levels in cured bacon. FSIS uses this information to determine whether or not a plant is in compliance.

OMB No. 0583-0015

U.S. DEPARTMENT OF AGRICULTURE
FOOD SAFETY AND INSPECTION SERVICE

PUMPED BACON SAMPLING PROGRAM-NITROSAMINE ANALYSIS PROCESS CHART

EST. NAME		EST. NO.
PROJECT NO.	COLLECTION DATE	PROCEDURE LABORATORY TESTED-ACCEPTABLE ☐ Yes ☐ No
NAME OF USDA OR ACCREDITED LABORATORY		FRY DATES:

BACON PICKLE FORMULA FOR: ☐ Skin On ☐ Skin Off

INGREDIENTS	LBS.	0ZS.
WATER	*1996.3*	
SALT	*302.2*	
SUGAR *(Dextrose)*	*156.3*	
SODIUM PHOSPHATE	*31.25*	
SODIUM ASCORBATE		
SODIUM ERYTHORBATE	*11.45*	
NITRITE *(Sodium)*	*2.5*	
NITRITE *(Potassium)*		
TOTAL	*2500*	

CURE CYCLE	PERCENT PUMP	*12%*
	DRAIN TIME	*30 MIN*
SMOKE CYCLE	TIME IN SMOKE	*7 –7.5 HR*
	PERCENT HUMIDITY	
	SMOKEHOUSE TEMP.	*125 -130°F*
	BACON INTERNAL TEMPERATURE	*126 -128°F*
COOLER CYCLE	TIME HELD	*1 – 7 DAYS*
	PERCENT SHRINK	*2 – 4*

SODIUM ERYTHORBATE OR SODIUM ASCORBATE LABELED LESS THAN 100% PURE? ☐ Yes ☐ No

IF YES, WHAT IS % ?

SUBMITTED FOR APPROVAL BY *(Plant Official Signature)*

DATE SIGNED

MONITORING SAMPLES SUBMITTED BY	DATE	PASSED	PRESUMPTIVE	SAMPLE NUMBER

DATE THE PROCEDURE WAS:

PLACED IN USE	DISCONTINUED	PLACED ON SHELF

CONFIRMATION SAMPLES SUBMITTED:

☐ PASSED ☐ FAILED

REMARKS

REGIONAL OFFICE USE ONLY

U.S.G.P.O.: 1986-490-936/47763/FSIS

Bacon Workshop

1. Based on the bacon pickle formula identified on page 47 (FSIS Form 10,520-1), calculate ingoing parts per million (ppm) for:

   Sodium erythorbate _____ ppm

   Sodium nitrite _____ ppm

2. The Procedure Schedule lists 04B04 (calculate % of pump). The inspection program employee selects 50 pork bellies from lot 1A1 (weight range 10-12 lb). The 50 bellies weigh 545 lb before pumping. After pumping, the same bellies weigh 604.5 lb.

   NOTE: Base your calculations on the amount of sodium nitrite in the bacon pickle formula identified on FSIS Form 10,520-1 (located on page 47).

   The actual % of pump is _____ %

   The ppm (based on the actual pump) is _____ ppm

   The pump procedure is acceptable YES _____ NO_____

Bacon Workshop (Continued)

3. The Procedure Schedule lists ISP code 04A01.

   50 uncured pork bellies are selected from lot 2B3 (12-14 lb weight range). The 50 pork bellies weigh 635 lb (green weight).

   50 cured/smoked bellies are selected from the cooler. These bellies range in weight from 12-14 lb each, and weigh 649 lb.

   The % yield is _____ %

4. Complete line 6 on the sample FSIS Form 7310-3 located on page 53, by entering:

   (1) Percent yield _____ %

   (2) The value added _____

   (3) Calculated yield difference _____

   (*Note*: The previous entries on the sample FSIS Form 7312-3 are the example tests results.)

Bacon Yield Difference Chart

% Yield	Value To Be Added To Yield Difference
90	-2.00*
91	-2.00
92	-2.00
93	-2.00
94	-1.75
95	-1.50
96	-1.25
97	-1.00
98	-0.75
99	-0.50
100	-0.25
101	0.00
102	0.25
103	0.50
104	0.75
105	1.00
106	1.25
107	1.50
108	1.75
109	2.00
110	2.25
111	2.50
112	2.75
113	3.00
114	3.25
115	3.50
116	3.75
117	4.00
118	4.25
119	4.50
120	4.75

*** Maximum Negative Value = -2.00**

BACON YIELD DIFFERNCE LOG			ESTABLISHMENT NO.	
% YIELD	VALUE ADDED	YIELD DIFFERNCE	INSPECTOR'S INITIALS	DATE
95	**-1.50**	**-1.50**	**KP**	**X-XX-XX**
100	**-0.25**	**-1.75**	**KP**	**X-XX-XX**
105	**1.00**	**-.075**	**KP**	**X-XX-XX**
108	**1.75**	**1.00**	**KP**	**X-XX-XX**
99	**-0.50**	**0.50**	**KP**	**X-XX-XX**
➔				

Regional Directors
ATTACHMENT 1

(Bacon Section)

Bacon Yield Determination
Question and Answers

1. Question: May an establishment submit a Partial Quality Control Program for bacon yield based on the concept given in the Directive?

Answer: No. The procedure in the Directive is intended only as a monitoring tool for inspection.

2. Question: Is the establishment responsible for providing assistance to the FSIS inspector when weighing green and finished bellies?

Answer: Yes.

3. Question: May a separate Yield Difference Log be kept for different weight ranges or process procedures?

Answer: No. Only one Yield Difference Log should be kept for an establishment. This log represents all bacon weight ranges and process procedures produced in the establishment subject to the Bacon Yield Determination Directive.

4. Question: If a plant lots green bellies in a wider than normal weight range, i.e., 10 – 15 pounds, is the bacon yield monitoring procedure adjusted for these wider ranges?

Answer: No. Regardless of lotting procedures plants must satisfy Regulation 319.107 and FSIS Directive 10,520.1.

5. Question: Is bacon produced by immersion, massage, or tumbling included in the Directive?

Answer: Yes

6. Question: Why does the Bacon Yield Directive allow the sample average of 50 bellies to exceed the 100% of green weight limit in Regulation 319.107?

Answer: The procedure for determining yield in the Directive is an indication of the process control not the lot yield. Plant management is responsible for assuring that the lot yield is in compliance with Regulation 319.107.

7. Question: Why isn’t there an individual sample maximum yield?

Answer: Because the Bacon Yield Directive is based on process monitoring and not individual lot control.

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8. Question: If green bellies are not available, may an average from previous weights be used?

Answer: No. When determining bacon yield during performance of a monitoring task, green bellies and finished bacon must be available to perform the task.

9. Question: Attachment 1 of the Bacon Yield Directive shows only whole numbers as the percent yield. What are the rounding rules for this directive?

Answer: All decimals which are 0.5 or greater will be rounded to the next whole number. Decimals less than 0.5 will be dropped.

10. Question: At what point is the proper time to select finished bacon from the cooler?

Answer: Select finished bacon samples from bacon that has been in the cooler for the minimum time established by plant management on FSIS Form 10,520-1. Bacon should not be packaged prior to completion of the minimum time specified on this form.

11. Question: What product is affected when a Yield Difference of 3.00 or greater is reached?

Answer: Bacon represented by the sample includes all weight ranges in process from in-plant lotting and trimming of uncured bellies up to slicing (sliced bacon and packaged bacon are not included). This is the "officially controlled lot(s)". This product is to be kept segregated from other product (i.e., hold and test) throughout its processing and testing.

12. Question: When Hold and Test procedures are in place which lot should be tested to verify preventive action?

Answer: Randomly select any weight range for which green bellies and finished product is available. If green bellies are not available, finished product lot(s) may not be released until plant management provides evidence acceptable to the IIC that the yield is in compliance. Such lot(s) are not counted towards the required five Hold and Test lots.

13. Question: What corrective action is required when the percent yield of a Hold and Test lot is 100% or less and the yield difference is 3.00 or greater?

Answer: Release shift production lot(s) of finished product and continue to restart the five consecutive production lot count as long as the yield difference is three or greater.

14: Question: What corrective action is required when the percent yield of a Hold and Test lot is greater than 100% and the yield difference is less than 3.00?

Answer: Release all shift production lot(s) of finished product represented by the sample. No corrective action is required.

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15. Question: May plant management's records demonstrating bacon lot yield be accepted when presented as part of their corrective action to indicate compliance with the regulatory standard?

Answer: Yes, provided the IIC has confidence in the reliability of the records.

16. Question: Do results from officially controlled lots appear on the Yield Difference Log?

Answer: No. Results from officially controlled lots may be noted on the PDR.

17. Question: Do retained lots count as part of the next five production lots?

Answer: No. Attachment 1 shows examples of the yield difference log when taking corrective action and monitoring subsequent production under Hold and Test Procedures.

BACON YIELD DIFFERENCE LOG			ESTABLISHMENT NO. 00038M	
% YIELD	VALUE ADDED	YIELD DIFFERNCE	INSPECTOR'S INITIALS	DATE
110	2.25	2.25		
107	1.50	3.75 (See A)		
Begin Hold and Test (See B)				
99	-0.50	3.25 (See Question 13)		
99	-0.50	2.75		
101	0.00	2.75		
102	0.25	3.00 (See A)		
Continue Hold and Test Procedures of subsequent production				
90	-2.00	1.00		
85	-2.00	-1.00		
93	-2.00	-2.00		
87	-2.00	-2.00		
102	0.25	-1.75		
Paragraph VIII (B) (3) has been satisfied, return to normal monitoring procedures.				
101	0.00	-1.75 (See C)		

A. Retain all bacon represented by sample (See Q&A #11). Request that plant management propose corrective and preventive action as stated in Paragraphs VIII (B) (1) and VIII (B)(2) of the Bacon Yield Directive.

B. Monitor subsequent bacon production as provided in Paragraph VIII (B)(3). Hold and Test procedures are performed by randomly selecting a sample (50 bellies green and finished) from shift productions.

C. The value added for the subsequent monitoring sample is added to the last hold and test yield difference.

SUPPLEMENT 4

This supplement includes exercises designed to assist the inspection program employee to determine the proper grouping of various cured pork products, identify their required PFF values, calculate required and absolute minimum PFF, calculate required shrinks, and identify FSIS actions.

I. Protein Fat-Free (PFF) Introduction

NOTE: The following information was derived from the "Cured Pork Products Guide: PFF (Protein Fat-Free)". Additional information is in FSIS Directive 7110.2, Rev. 1, "Update of Protein Fat-Free (PFF) Instructions" and §319.104 and §319.105.

This information explains the procedures used to monitor added moisture and added substances in cured pork products based on the minimum percentage of meat protein, on a fat-free basis, present in the finished product.

The PFF Regulation

This PFF regulation emphasizes that the responsibility for controlling compliance is the plant's. The compliance system established by the regulation makes no pretense of controlling the *product* but is intended to detect whether or not the plant is controlling the process and preparing products in compliance. PFF is the meat protein content expressed as a percent of the nonfat portion of the finished product. This definition allows the monitoring of all added ingredients by regulating the meat protein in the nonfat portion of the cured pork product, since anything added to the product dilutes the natural meat protein content. A comparison of added ingredients with PFF using the same analytical information shows why regulating the meat protein content also monitors the added substances. Note on Table 1 that as added ingredient levels increase, the PFF content decreases.

Table 1. Results of Calculations for Added Ingredients and PFF

% Added Ingredients	% Protein on a Fat-Free Basis, Ham
0	22.00
5	20.95
10	20.00
15	19.13
20	18.33
25	17.60
30	16.92

The Protein Fat-Free procedure reflects the presence of added ingredients, including water, and relates labeling claims to the percent of meat protein in the product on a fat-free basis.

Protein Fat-Free Determination

Protein Fat-Free (PFF) is a percentage derived from laboratory analyses for protein and fat. The following formula is used to determine the PFF of cured pork products from the laboratory findings that are received.

$$PPF = \frac{\%\ \text{Meat Protein by Analysis}}{100 - \%\ \text{Fat by Analysis}} \times 100$$

Ingredients that contribute some protein content may be added to cured pork products, but their presence and amounts must be included on the laboratory form accompanying the sample. The FSIS program employee is required to furnish enough information for the laboratory to calculate the amount of nonmeat protein added in the finished product. The laboratory will then deduct the amount of protein contributed by the additive before calculating the meat protein content. The use of meat protein as the basis for determining which labels may be used increases the importance of all calculations performed by the FSIS program employee through the addition of nonmeat proteins. Common items such as H(V)P, H(P)P, and other high protein additives are subtracted. Accurate reporting of all nonmeat proteins to the laboratory is therefore essential to determine PFF content. Examples of protein-contributing ingredients are listed in Table 2 below.

Table 2. Protein-Containing Additives

Type or class	Name
Yeast products	Hydrolyzed yeast
	Autolyzed yeast
	Yeast extract
Animal products	Milk protein hydrolyzate
	Gelatin
	Dried (species) stocks (ham flavors)
	(Species) extracts
	Collagen
	Ham stocks
	Sodium caseinate
Plant products	Mustard
	Spice mixtures (not including mustard)
	Hydrolyzed (plant) protein
	Hydrolyzed (vegetable) protein
	Monosodium glutamate (MSG)
	Isolated soy protein (ISP)

Note*: *The FSIS program employee must accurately calculate all Group 2 proteins and state the amounts on the lab sample form.

The names of the items included in this list are not always the names used on the ingredient list. Many brand names are used. If there is any doubt about the protein content of an ingredient, the FSIS program employee should ask the user of the ingredient for the protein content.

PFF Rounding Rules

The rounding rules state that all PFF values will be calculated to thousandth and rounded to hundredths, and that compliance will be based on the PFF values rounded to tenths. Values of five thousandths (.005) or five hundredths (.05) will be rounded to the next highest hundredth or tenth, as appropriate. Values of less than five thousandths or five hundredths will be dropped.

Example:

Meat protein = 15.50
Fat = 10.30

$$\frac{15.50}{100 - 10.30} = 0.17279 \times 100 = 17.279 \text{ (calculated to thousandths)}$$

Rounded to hundredths = 17.28 PFF
Rounded to tenths = 17.3 PFF
The PFF would be reported as 17.3.

PFF Standards

Calculations such as these, from samples of cured pork products collected by FSIS, are the basis for the PFF standards. They make reasonable allowances for the usual solids (salt and extenders) and the range of fat content normally found in cured pork products. Due to the importance of these standards, several hundred analyses of cured pork products from FSIS laboratories were evaluated to confirm them. In addition, data from a statistical study (conducted to determine the tolerances to allow) affirmed their validity. Here are the standards for cured pork.

Section 319.104 Cured Pork Products.

Cured pork products, including hams, shoulders, picnics, butts, loins, and ham shanks shall comply with the minimum meat PFF percentage requirements set forth in Table 3.

Finely Divided Cured Ham Products

In addition to the previously mentioned cured pork products, finely divided (chopped, ground, flaked, chipped) cured ham products such as “ham patties”, “chopped ham”, “pressed ham”, and “spiced ham” shall comply with minimum meat PFF percentage requirements. The regulations also apply to those products that are finely divided, thinly sliced, and packaged for sale in market deli counters.

Uncooked cured products are also covered by PFF standards. They are grouped according to whether they are bone-in or boneless. Those uncooked cured products that are produced *only* for further processing by another processor and are *not* shipped into the marketplace, will *not* be subject to PFF sampling. This regulation is concerned with those products that will be available to the consuming public. Those products processed *only* for further processing must be properly labeled, e.g., “for further processing,” before shipment to ensure that none of this product can enter the marketplace.

Additionally, those cured pork products that have small amounts of curing brine (concentrated or normal) injected around the bone in the meat cut as an aid in the prevention of spoilage during an otherwise dry curing procedure, are subject to the PFF regulation. Some processors have been using this method of curing and then labeling their products as “Dry Cured.” Such products do not meet the dry cured standard and should be labeled with the common and usual name in §319.104.

Unusual products that are also covered by the PFF regulation are the cured pork/other meat or poultry combinations bearing a meat legend. These products may be labeled with the common and usual cured pork product name and the common and usual name of the other meat, such as “ham and turkey product” or “ham and chicken product”. They are subject to the minimum PFF requirement of the pork item, e.g., “ham and turkey” item would have the common and usual name and a minimum PFF of 20.5. *To date, turkey ham is not covered by the PFF regulation.*

Table 3. Cured Pork Products

Type of Cured Pork Product	Minimum Meat PFF Percentage[1]	Product Name and Qualifying Statement
Cooked ham, loin	20.5	(Common and usual)
	18.5	(Common and usual) With Natural Juices
	17.0	(Common and usual) Water Added
	Less than 17.0	(Common and usual) and Water Product—X% of Weight is Added Ingredients[2]
Cooked shoulder, butt, picnic[2]	20.0	(Common and usual)
	18.0	(Common and usual) With Natural Juices
	16.5	(Common and usual) Water Added
	Less than 16.5	(Common and usual) and Water Product—X% of Weight is Added Ingredients[2]
Uncooked cured ham, loin	18.0	Uncooked (common and usual)
	Less than 18.0	Uncooked (common and usual) And Water Product—X% of Weight is Added Ingredients[2]
Uncooked cured shoulder, butt, picnic	17.5	Uncooked (common and usual)
	Less than 17.5	Uncooked (common and usual) And Water Product—X% of Weight is Added Ingredients[2]

[1] The minimum meat PFF percentage shall be the minimum meat protein that is indigenous to the raw, unprocessed pork expressed as a percent of the nonfat portion of the finished product; and compliance shall be determined under section 318.19.

[2] Processors may immediately follow this qualifying statement with a list of ingredients in descending order of predominance rather than having the traditional ingredients statement. In any case, the maximum % of added substances in the finished product on a total weight percentage basis would be inserted as the X value; e.g., "Ham and Water Product -- 20% of Weight is Added Ingredients".

Table 4. Finely Divided Cured Ham Products

Type of Cured Pork Product	Minimum Meat PFF Percentage[1]	Product Name and Qualifying Statement
"Ham Patties,"	19.5	(Common and usual)
"Chopped Ham,"	17.5	(Common and usual)
"Pressed Ham," and "Spiced Ham"	16.0	With Natural Juices (Common and usual)
	Less than 16.0	Water Added (Common and usual) and Water Product—X% of Weight is Added Ingredients[2]

[1] The minimum meat PFF percentage shall be the minimum meat protein that is indigenous to the raw, unprocessed pork expressed as a percent of the nonfat portion of the finished product; and compliance shall be determined under section 318.19.

[2] Processors may immediately follow this qualifying statement with a list of ingredients in descending order of predominance rather than having the traditional ingredients statement. In any case, the maximum % of added substances in the finished product on a total weight percentage basis would be inserted as the X value; e.g., "Ham and Water Product -- 20% of Weight is Added Ingredients".

The product label will determine which PFF standard is used to evaluate compliance.

Ham -- Cooked and Labeled	Minimum PFF
Ham	20.5
Ham, w/ Natural Juices	18.5
Ham, Water Added	17.0
Ham and Water Product X % of Weight is Added Ingredients	Less than 17.0

Cured Pork Products Not Covered by PFF

Bacon will ***not*** have a PFF requirement, but will remain under the regulatory requirement of "back to green weight". A PFF for bacon would be improper since bacon contains such a small amount of lean, and a significant increase of added water could change the nature of the product. This includes slab, sliced, and jowl bacon. Other cured pork products that are not specifically mentioned in the regulation (§319.104 and §319.105) continue to be regulated by the requirement to return to green weight before shipment when heat processed. These include the products with fanciful names and those that do not profess to be a product for which the standard is established. Examples of some cured pork products that are ***not covered*** by this regulation are: hocks, ears, snouts, feet, knuckles, tails, and fatback.

Sausages and dry cured pork products are also ***excluded*** from PFF requirements.

Product Groups

Product with gross similarities in processing procedures were grouped together into four compliance Groups to increase the efficiency of the statistical compliance monitoring program. See Table 5.

Table 5. Product Groups

Group	Description
I	Cooked while imperviously encased
II	Water cooked, pervious container
III	Boneless, smokehouse heated
IV	Bone-In and Semi-Boneless, Smokehouse heated

Note: Pork products that are cured (pumped) and uncooked are also included within a Group, dependent upon product characteristics, e.g.:

Cured uncooked boneless ham—Group III
Cured uncooked bone-in pork shoulder—Group IV

Group Identification, Product Code Identification

To further assist in properly classifying products included in the computer system, the FSIS program employee should review the plant's product labels and become familiar with where each would fit into the Groups of Table 5. All cured pork products are placed within one of four Groups. The Groups are prioritized for sampling and control purposes. Information has already been collected about the types of cured pork products produced in each plant, and the products have been sorted into their respective Groups in the computer.

Note: It is the responsibility of the IIC to keep the FSIS data base updated as new products are produced or existing products are discontinued. This is done by completing FSIS Form 7110-1 (see page 79) and forwarding it to District Office.

To determine the Group for a product, Group I is the first consideration, regardless of additional attributes. If product cannot be classified in Group I, proceed to Group II and so on.

Some products may appear to be in more than one Group, but only one is applicable.

Canned Ham is:

- Always imperviously encased (Group I)
- Usually water cooked (Group II)
- Boneless (Group III)

Refer to Table 5. The product is imperviously encased, and therefore, is classified as Group I. Regardless of additional attributes, the primary consideration is imperviously encased.

Absolute Minimum PFF Values

All the statistics and computer assistance in the world cannot take into consideration the process that suddenly gets out of control without anyone noticing a change and results in production of noncomplying product. For that reason, the regulation establishes an Absolute Minimum PFF for each Group of products. The "Absolute Minimum PFF" is that PFF of a single sample that is so far below the standard that the lot cannot possibly have a lot average which is equal to the standard and must therefore be retained.

The Absolute Minimum PFF for a product depends on its Group. A constant will be subtracted from the standard for each product to give an Absolute Minimum Value for each Group. Table 6 gives the constants used for each Group.

Table 6. Absolute Minimum PFF Values

Group	Constant*
I, II	2.3 Below minimum PFF
III, IV	2.7 below minimum PFF

* There is a limit below which the PFF of a cured pork product cannot occur when the processor is targeting at or above the standard and has process controls with standard deviations no greater than prescribed in this regulation. This limit has been estimated as equal to or less than three standard deviations below the PFF standard.

One standard deviation for Groups I & II = 0.75
Three standard deviations = 2.3
Appropriate PFF Standard 2.3 = Absolute Minimum for the product

One standard deviation for Groups III & IV = 0.91
Three standard deviations = 2.7
Appropriate PFF Standard 2.7 = Absolute Minimum for the product

Summary

The following examples briefly summarize the steps necessary to determine if a product needs to be retained.

Example 1: Product controlled by PFF:

Product: Cooked ham or loin (bone-in), smokehouse heated

This product is a ham or loin with no qualifying statement; it therefore is required to have a minimum PFF of 20.5.

This product is not imperviously encased. This product is not water cooked. It falls into Group IV.

Required Minimum PFF	20.5
Constant (Group IV)	- 2.7
Absolute Minimum	17.8

If the PFF of the sample taken is 17.8 or less it must be retained.

*Example 2: Product **NOT** controlled by PFF:*

Product: Deli ham and water product, 20% of weight is added ingredients

This product is not imperviously encased. This product is water cooked in a pervious container (e.g., a mold).

This is a ham and water product and the X % is controlled by means other than PFF. There is no minimum required PFF. There is no applicable constant and Absolute Minimum PFF. The processor must document that the 20% declared on the label is the maximum amount of added ingredients present in the product. This is usually done through use of yield data from the plant, but if the processor wishes to control the "20% of weight is added ingredients" by an alternate means he/she may do so.

Sampling

The sampling rate will be variable, with increased sampling when low PFF values are anticipated and the history of compliance is poor.

As a history is built, sampling may be increased or decreased based on past compliance. Use of a computer to keep track of each processor's history allows predictions to be made about the likelihood of producing noncomplying products. This allows sampling for all processors to be directed from one location. This does not stop an FSIS program employee from taking samples of product where there is strong reason to believe the product is adulterated or misbranded. However, when this is done the results of such samples will not be included to determine the frequency of sampling.

Products that are purchased by a processor for slicing or dicing and are labeled with the same common and usual name as the product had before it was sliced or diced are not subject to sampling. Also, those products that are resmoked without changing the label are not subject to sampling. However, if the product is relabeled with either an upgraded or downgraded label, the reprocessed product is subject to sampling and the product must be evaluated for compliance with the standard that it purports to meet.

Phases

Under the regulation, FSIS has established three compliance sampling phases:

1. Periodic Sampling Phase

2. Daily Sampling Phase

3. Retention Phase

Only one of these takes place at any given time for any one product. All request for samples will be computer-generated.

Periodic Sampling Phase. A single product representing each Group is sampled periodically. In the periodic phase, samples will be collected at a moderate, predetermined rate. Analysis of laboratory findings from this phase could result in continued periodic sampling, daily sampling, or retention. In addition, quick follow-up samples will be taken from randomly selected processors at a low rate to ensure that the processors cannot predict the rate of sampling.

Periodic sampling becomes daily sampling when the Group Value for the Group is exceeded by the Action Limit (-1.40 or less). Both the Action Limit and Group Value are defined in the PFF regulation.

Daily Sampling Phase. In daily sampling, one sample of a single product representing a Group is taken daily. Analytical results dictate:

(1) a return to periodic sampling, if no problems appear;
(2) continued daily sampling, if the process appears to be going out of control but is not out of control yet; or
(3) retention, if either gross PFF shortages appear (violations of the Absolute Minimum), or a series of lesser PFF shortages in samples were not balanced by PFF overages, resulting in the Product Value declining past the Action Limit (-1.65 or less). (The Product Value is the mathematical value defined in the regulations for each individual product. The Action Limit is the Product Value that indicates that the lot average PFF can no longer be equal to the PFF standard and the product being produced is adulterated or misbranded.)

Retention Phase. FSIS regulations established Absolute Minimum PFF requirements and also Product Value Action Limits for most cured pork products. Should a single sample fail to have a PFF higher than the Absolute Minimum or should the PFF of the sample cause the Action Limits for the Group Value and the Product Value to be met or exceeded, the affected lot is retained. In the retention phase, no like product may enter commerce until laboratory analyses demonstrate that the minimum PFF Standards are met by collecting three randomly selected samples from each lot and analyzing them individually for PFF content. The average PFF of the three samples is the PFF of the lot. (*Note*: See the next section on "Release of Retained Product" for information about the potential for use of alternate sampling procedures during retention.)

The establishment has the option of temporarily removing a product from its product Group provided product lots are being "U.S. Retained" as produced, and provided further that the average production rate of the product, over the 8-week period preceding the week in which the first "U.S. Retained" lot was prepared, is not greater than 20% of the production rate of its Group. When a product is thus removed from its Group, analytical results of product samples shall not cause daily sampling of the Group to continue.

Those processors of cured pork products that are in special compliance categories and, for some reason, require special sampling procedures different from those discussed here, will have the sampling rate set by the District Office. This special sampling procedure will be programmed into the computer and the computer *will* generate the sample requests. IICs in these types of plants will receive sample requests on a monthly schedule. Samples collected in these plants will be randomly selected.

Release of Retained Product

The retained lot may be released for entry into commerce ***if****:*

1. The average PPF content of the three samples taken from the lot is equal to or greater than the applicable minimum PFF percentage required. If the processor does not wish to have the product evaluated in this manner, alternate sampling plans may be used provided the analyses specified in such plans are performed at the expense of the processor; or

2. The product is further processed to remove moisture to meet the applicable PFF percentage required; *or*

3. The lot of product is relabeled to conform to the provisions of §319.104 or §319.105. If the retained lot is a product that was supposed to be a "water added" product and must be relabeled as an "X% of Weight is Added Ingredients" product, be aware that the "X" represents the maximum percent of added substances in the finished product on a total weight percentage basis. It is *not* the amount of yield above green weight in a cooked product.

Computer-Generated Sample Request

Computer-generated sample requests will be received in the plant at varying rates. The dates and the products to be sampled are randomly generated depending upon compliance history, production volume, proximity of the Group Value and Product Value to their respective Action Limits, and likelihood of noncompliance. *The sampling dates, and the products which are to be sampled, are not to be shared with the plant.* Samples should be collected as near as possible to the dates in the sample request form.

In daily sampling, if the product requested is not available, an alternate product that is not in retention is to be chosen from the same Group on the day specified. If none of the alternative products are available, hold that sample request until the next day the Group is available and a sample can be collected. Each daily sample request is sequentially numbered and not dated to insure sequential collection of samples. After seven days of daily sampling, the status of the daily sampling will be reviewed by the computer. If the plant has satisfied the criteria for return to periodic sampling, the IIC will be notified. All daily sampling requests are to be fulfilled until other direction is received. If additional daily sampling forms are needed, request these from the District Office.

Retention sample request will be handled in a similar manner to the daily sample requests, with the exception that the first review of the plant's status will be made after only five days.

FSIS Program Employee Determination of Absolute Minimum

Ordinarily, the FSIS program employee will be instructed when to take samples, and appropriate actions will depend on laboratory results. However, when results are received from an accredited laboratory, the FSIS program employee is required to calculate the Absolute Minimum and determine if the actual product PFF is equal to or less than the Absolute Minimum.

Example: Cooked Ham, boneless, imperviously cased

Required PFF	20.5 (Groups I, II)
Laboratory PFF	-18.0
(from FSIS program employee's calculation of laboratory analysis of meat protein and fat percentages)	2.5 below required PFF
or	
Required PFF	20.5
Tolerance (Group I)	- 2.3
(from Table 6, page 65)	18.2 Absolute Minimum

18.0 (sample analysis PFF) is below the Absolute Minimum of 18.2.

If the PFF of the sample is equal to or less than the Absolute Minimum (as in the example above), the entire lot represented by the sample will be retained. In addition, all subsequent lots of the same product will be retained pending release through laboratory analysis. The "same or like product" makes no distinction among different trade labels or net weights, but refers to product within the same group, meeting the same PFF standard, and bearing the same common or usual name with qualifiers.

A single sample triggers retention of product if the PFF is equal to or below the Absolute Minimum. This retention would involve only the product in violation and not the entire Group. Sampling of the Group would be increased to daily sampling, but other products in the Group would not be retained unless the PFF of a sample was equal to or less than the Absolute Minimum PFF or the Product Value of one of the other products exceeded the Product Action Limit.

Processors' Options During Retention

At the option of the processor, any retained lots may be further processed to remove moisture or relabeled to show the PFF found by laboratory analysis. If reprocessed in accordance with the regulations, each 3.7% weight reduction due to moisture loss resulting from reprocessing may be considered the equivalent of 1.0 PFF unit gain. A calculation for shrink can determine how much reprocessing is necessary.

Calculating Absolute Minimum and Three-Sample Average

1. Determine the Absolute Minimum PFF for product, e.g., Cooked Ham (Group 1) --required PFF, 20.5 (Group 1 constant = 2.3)

2. Subtract the Group constant from the required PFF standard. The result will be the Absolute Minimum PFF.
   Example:
   20.5 Required minimum PFF
   - 2.3 Constant for Group
   18.2 Absolute Minimum PFF

3. Determine if any of the 3 PFF samples are equal to or less than the Absolute Minimum.

	Sample Results
	18.8
Absolute Minimum: 18.2	19.3
	19.6

   If any sample result is equal to or less than the Absolute Minimum, the 5-shift retention count starts over.

4. In this case, no PFF result was equal to or less than the Absolute Minimum.

5. Average the three individual PFF samples derived from the accredited lab.
   18.8 + 19.3 + 19.6 = 57.7
   57.7 ÷ 3 = 19.23 average

6. Round sample average to tenths.*
   19.23 = 19.2

7. Compare average PFF with required PFF standard.
   Average PFF = 19.2
   Required minimum PFF = 20.5
   (Average PFF is not equal to or more than the required minimum PFF standard.)

8. Determination: Lot must be reprocessed or relabeled. ‡

*0.05 or more, round up; less than 0.05, drop.
‡If reprocessed, the FSIS program employee determines release based on the 3.7% reduction equal to 1.0 PFF increase. In this case, if the lot were relabeled, it may be labeled "Ham with Natural Juices".

Calculating PFF Gain

Rules: A) Each 3.7% weight reduction is equivalent to a 1.0 PFF unit gain. B) All reprocessed product must be reprocessed until the lot average PFF is equal to or greater than the required minimum PFF.

1. Determine the difference between the required minimum PFF (20.5) and the calculated lot average PFF (19.2).

    20.5 Required PFF (Standard)
    - 19.2 Calculated lot average PFF
    1.3 Gain required to meet required minimum PFF

2. Multiply 1.3 X .037 (3.7%) = 0.0481.
    (0.0481 X 100 = 4.81%)

3. Multiply 0.0481 (4.81%) by the lot weight (10,000 lb).
    0.0481 X 10,000 = 481 lb minimum to shrink

4. Subtract the weight reduction required (481 lb) from the lot weight (10,000 lb).
    10,000 lb - 481 lb = 9519 lb maximum reprocessed weight

PROTEIN FAT-FREE

(An Overview)

PFF Regulation

- Minimum Protein Level for Nonfat Portion
- Compliance Monitoring System for PFF Products

Considerations

- Labeling is the key distinguishing between products
- The label directly relates to the meat protein content
- Labeling determines the minimum PFF for the product
- PFF is based on direct lab analyses
- PFF reflects the presence of all the ingredients used in preparing these products
- There is a variable sampling rate, based on processor's control performance
- PFF sampling monitors process control

Definition of Product

- All cured pork articles within one group subject to the same PFF requirement and bearing the same common and usual name

Retained Product / Retention Phase

- Discontinued when:
  1. After 5 production shifts, product value is 0.00 or greater; and
  2. No individual PFF sample is below the Absolute Minimum PFF

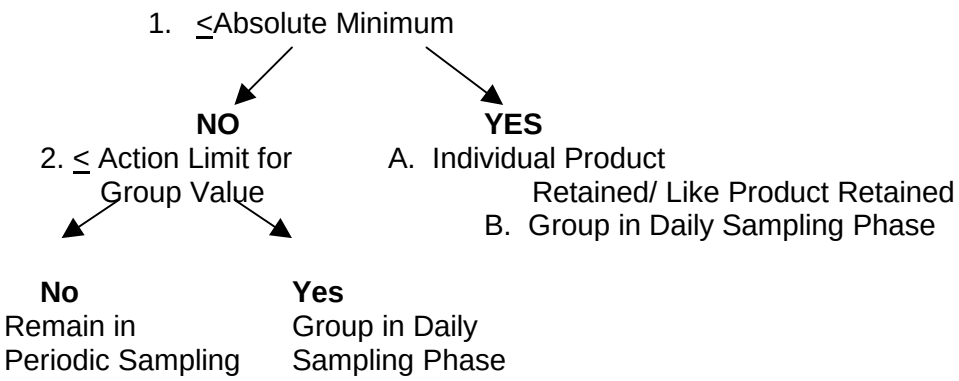
Remove Product from PFF Group if:

- Product lots are being retained; and
- Average production rate for 8 weeks before retention phase is no more than 20% of the production rate of the Group

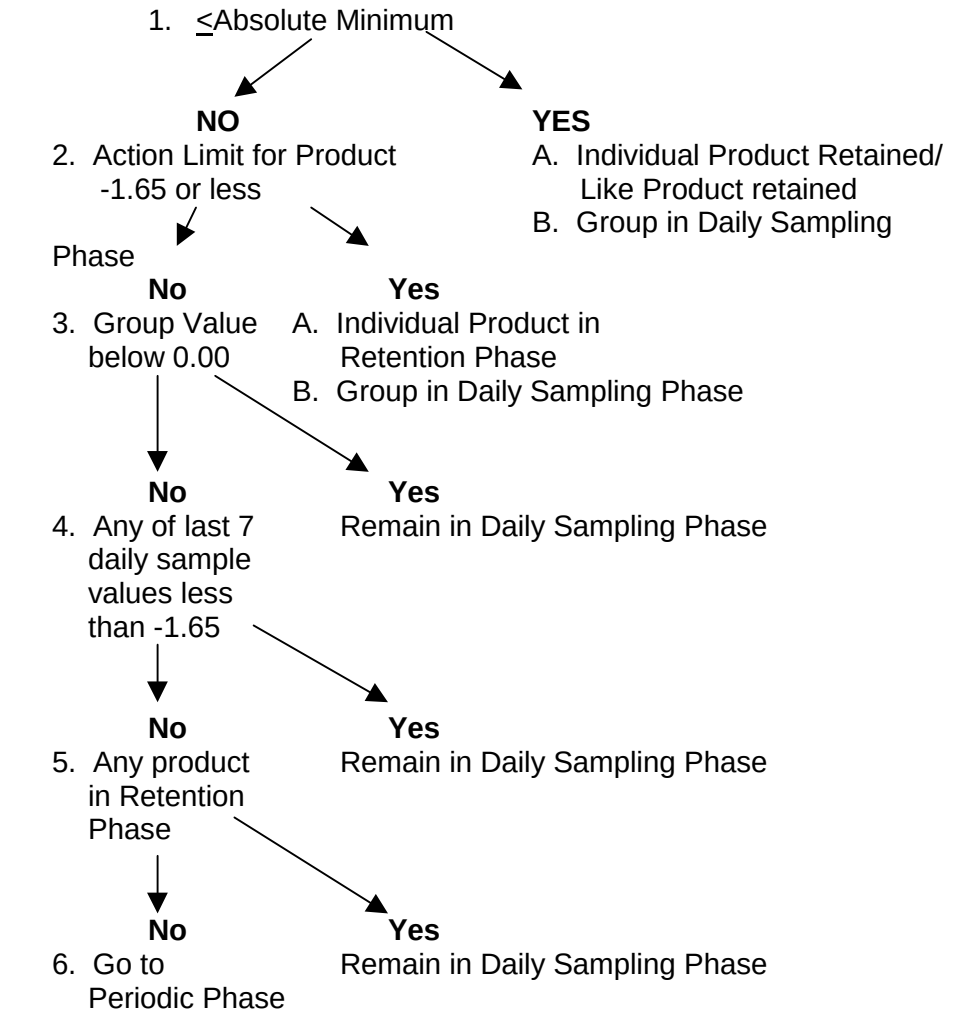
Sampling Phases

- Periodic Sampling Phase
- Daily Sampling Phase
- Retention Phase

Periodic Phase



Daily Sampling



Retention Phase

1. Average of 3 samples less than Required PFF

NO

2. Product Value less than zero after 5 shifts

YES
Product reprocessed or relabeled

NO

3. Any of last 15 (3 samples for 5 lots = 15) samples ≤Absolute Minimum

YES
Remains in Retention Phase

NO

4. Go to Daily Sampling Phase

YES
Remains in Retention Phase

Release Retained Product

Average of 3 samples meets or exceeds required minimum PFF

Lot reprocessed to shrink back to required minimum PFF

Relabel if meets or exceeds required minimum PFF for the type of product below the targeted PFF

FSIS program employee-Generated Sample

I lb. sample ≤Absolute Minimum

NO
No action

YES

A. Retain lot; take 3 samples

B. Retain subsequent like product; begin Retention Phase

C. Continue Retention Phase until notified by District Office

II. PFF Exercise Questions

1. Place each of the following cured pork products in the proper Group, along with the required minimum PFF as per Table 3 of the "Cured Pork Products Guide: PFF (Protein Fat-Free)".

   a. Ham, with natural juices in an impervious container

      Group _____ Minimum required PFF _____

   b. Fully cooked ham, smokehouse heated, bone-in, common and usual

      Group _____ Minimum required PFF _____

   c. Water-added and water-cooked ham in molds or pervious containers

      Group _____ Minimum required PFF _____

   d. Canned pork shoulder picnic with natural juices

      Group _____ Minimum required PFF _____

   e. Smokehouse-heated ham, bone-in, common and usual

      Group _____ Minimum required PFF _____

2. State the 3 sampling phases as stated for PFF.

3. Define PFF.

4. Here are product results received from an accredited lab.

   a. Calculate the PFF for a bone-in smokehouse heated cooked ham (common and usual) with 14.15% meat protein and 10.05% fat. What is the required PFF for this product?

   b. Calculate the Absolute Minimum PFF.

   c. What action should be taken?

   d. Assuming that the three-sample average is 15.7 PFF, how many pounds would the product need to be shrunk to comply with the required PFF, if the lot weight is 5569 pounds?

   e. Would it be acceptable to relabel the product if the plant wished?

PFF PRODUCTION VOLUME INFORMATION SURVEY

NAME OF INSPECTOR (Please Print) | DATE

PLANT ADDRESS:

RETURN ADDRESS (Regional Office)

DOES PLANT HAVE THE FOLLOWING:

	Yes	No
TOC System	☐	☐
POC X% Prds	☐	☐
POC PFF Prds	☐	☐

Cured Pork or Cured Turkey Ham Products monitored by these programs should not be included on this survey form.

PLANT NO. | EST. TELEPHONE NO. | AREA CODE ☐☐☐ | CIRCUIT CODE ☐☐

SEE INSTRUCTIONS ON REVERSE SIDE

PRODUCTION VOLUME *(Please submit the production volume in pounds, for 4 quarters)*

NAME AND QUALIFYING STATEMENT (as labeled)	PRODUCT GROUP		(Place √) in appropriate column) Improv	Water	Bone-	Bone-	1ST J	F	M	2ND A	M	J	3RD QUARTER J		A	4TH S	O	N
							J	F	M	A	M	J	J		A	S	O	N
							J	F	M	A	M	J	J		A	S	O	N
							J	F	M	A	M	J	J		A	S	O	N
							J	F	M	A	M	J	J		A	S	O	
							J	F	M	A	M	J	J		A	S	O	D
							J	F	M	A	M	J	J		A	S	O	D
							J	F	M	A	M	J	J		A	S	O	D
							J	F	M	A	M	J	J		A	S	O	D
							J	F	M	A	M	J	J		A	S	O	D
							J	F	M	A	M	J	J		A	S	O	D

In order to generate a sample request for cured pork or cured turkey ham product subject to the Protein Fat Free (PFF) regulations, we need current data. For each of these cured pork or cured turkey ham products produced in the plant we need product name and qualifying statement, product group, product code, and establishment volume by calendar quarterly production. NOTE: All Turkey Ham products are in Group VIII.

The information should be submitted by class of product, using the class listed below. The regulations include only the following classes of cured products and does not include dried cured products, bacon, loaf type products, deviled ham, ham sausage, or turkey picnic.

PRODUCT CODE CHART

Product	Code	Product	Code
Ham, heat treated	01	Spiced ham water added, heat treated	18
Ham with natural juices, heat treated	02	Pressed ham water added, heat treated	18
Water added ham, heat treated	03	Chopped ham with water added, heat treated	18
Loin, heat treated	04	Ham shanks, heat treated	19
Loin with natural juices, heat treated	05	Ham shanks/natural juices, heat treated	20
Water added loin, heat treated	06	Ham shanks, water added	21
Shoulder, heat treated	07	Patties, heat treated	25
Shoulder with natural juices, heat treated	08	Ham, not heat treated	26
Water added shoulder, heat treated	09	Patties with natural juices	27
Butt, heat treated	10	Patties, water added	28
Butt with natural juices, heat treated	11	Loin, not heat treated	29
Water added butt, heat treated	12	Shoulder, not heat treated	32
Picnic, heat treated	13	Butt, not heat treated	35
Picnic with natural juices, heat treated	14	Picnic, not heat treated	38
Water added picnic, heat treated	15	Ham shank, not heat treated	44
Spiced ham, heat treated	16	No alternative available	51
Pressed ham, heat treated	16	Turkey Ham	81
Chopped ham, heat treated	16	Turkey Ham--Natural Juices	82
Spiced ham/natural juices, heat treated	17	Turkey Ham--Water Added	83
Pressed ham/ natural juice, heat treated	17	Turkey Ham--20 Percent Water Added	84
Chopped ham/ natural juice, heat treated	17	Turkey Ham--Chopped	85

INSTRUCTIONS

1. Refer to the chart above and Directive 7110.2 Protein Fat Free (PFF) Guidelines to aid you in determining proper grouping and product codes.
2. Refer to Regulation 318.19 (a) (2) and 381.171. Identify the Group number either I, II, III, IV, or VIII according to the regulations. Each product can be in only one group. NOTE: All Turkey Ham products are in Group VIII.
3. Identify the product code using two digits according to the Product Code table above. Example: "Ham water added smokehouse heated" would be Group IV and product code 03. "Turkey Ham Water Added" would be Group VIII and product code 83.
4. Enter the total quarterly production for each product. Use the four previous calendar quarters for which you have data.
5. There should be only one entry on this form with the same group number and product code.
6. Identify the months that the product is produced by placing a check mark in the space provided.
7. Upon completion return this survey form to the regional office.
8. Any future significant changes (*i.e. the addition of a new product, a new group, or a significant change in quarterly production)* must be reported to the Regional Office for entry into the database.